Bachelor Thesis

Software for telecommunication services automation

Project developed in Alcatel-Lucent Spain

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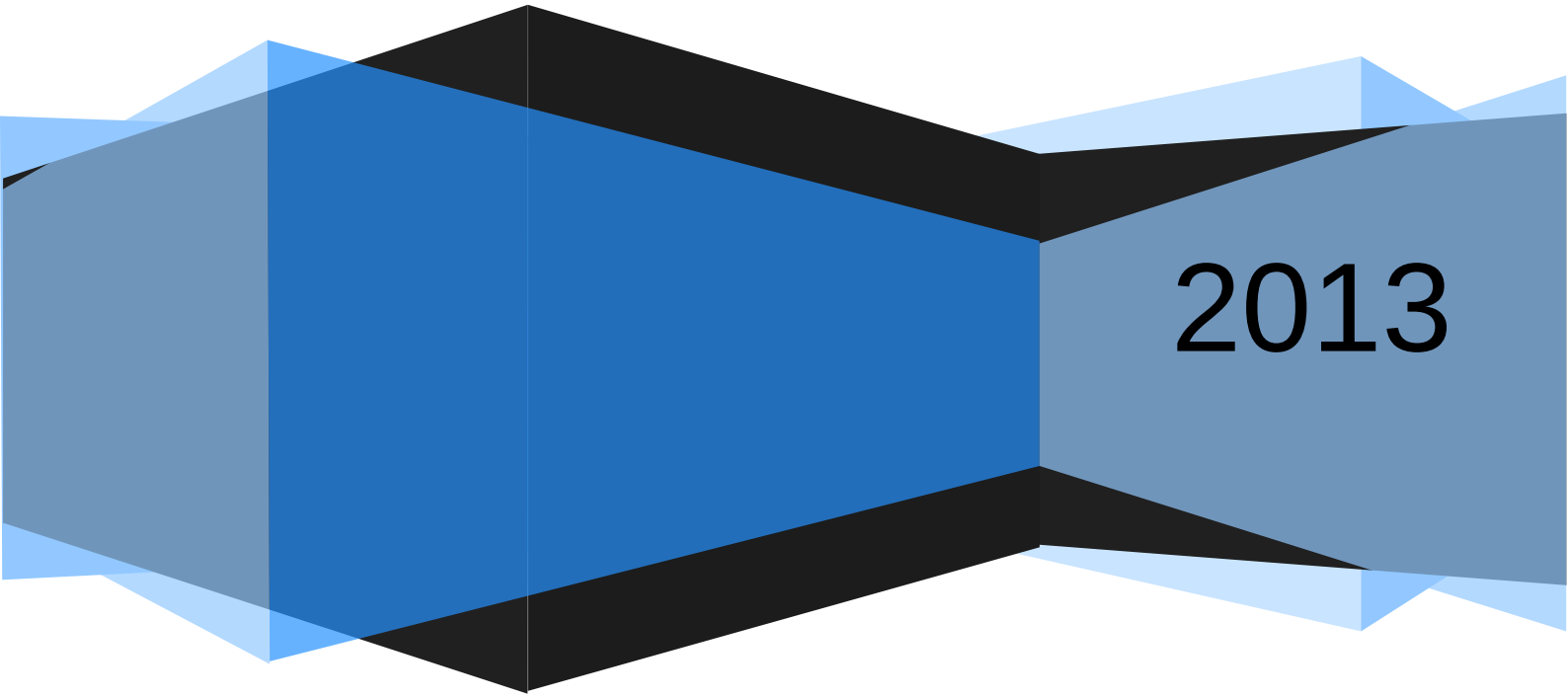

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1. Introduction

1.1. Motivation

It is really important for me to feel good with what I am doing, not just to have the feeling I am completing the bachelor thesis and that I will finish my degree in less than six months, but to know that what I am performing, the project in which I am spending my hours is useful for me in terms of opportunities and gaining knowledge.

Just as my mates, I had the opportunity of developing a project on my own, being able to put in practice my ideas. This was also challenging and I am sure it is possible to learn a lot from it, however, I finally decided to take part in a huge project already running in a company as I thought this could teach me different things that I couldn't learn at university.

I worked last year for ISBAN (Banking Software Engineering) and learned a lot from it, although it was quite different to the tasks I carry out in Alcatel-Lucent. In this previous labor experience, I performed tasks that had more to do with those a conventional scholar would carry out. Such a thing doesn't happen currently in ALU, here I am now treated (professionally speaking) as any other worker that goes to the office eight hours per day and earns an engineer salary, with this I am trying to say that I share tasks, objectives and work with other experienced workers, therefore I am expected to provide the same quality level and performance in every step and piece of work.

It is quite motivating, feeling as if you are completely involved in the professional area of the software development, it is just as I imagined and this is the reason of getting involved in this project. When I had the first interview, I was told that it was going to be like this, that I was being hired to help with the project and not to be another scholar in charge of carrying out simple tasks as filling an excel spreadsheet with irrelevant numbers, and probably this was what really made me decide for it, and started thinking about developing my last degree project at the time I took part in ALUs biggest project nowadays.

Taking part into such a project in a company can offer me different things, ones that developing the project on my own can't. The first thing to highlight is the time management and organization facts. Asking some questions to some graduated friends, I became aware about the time they spent on their projects, they told me they spent an average of 8-10 hours per week during the last four months of the course, and that these hours where dedicated whenever possible, so when they had free hours they worked on the project. This takes me to think about how comfortable it is to carry on the project development on your own, but also to appreciate the good habits learned when working on an

enterprise project. My job at ALU provides me both, the schedule flexibility advantages individual projects offer and the responsibility cooperation and constancy values an important company can teach me.

I currently work on the project the full time I do it for the company, this is four hours per day. I have always been told at work, that my priority should be my studies, and that my journey there is flexible, being able to assist to the office the four hours of the day that better fix into my schedule. Advantages and understanding of my situation don't stop here, I am able to work at home twice a week, although I normally do it once, and on busy days they allow me to go less hours that would be recovered further on the week. Of course, as in any other scholarship, on exam days, they give me the whole day to prepare the exam and assist to it without worrying about the work to be done on the company project.

For all the exposed reasons I can say that they offer me the best possible alternative to an individual project, giving me the chance of working for them and learning from them in the sense that I acquire experience, formation and I am assigned responsibilities, all this at the same time they allow me to work with the flexibility and self-organization of a researcher on his own.

There are other reasons that made me choose this path, but not as important as the already mentioned ones. My work in the company is paid, this really helps when paying transport costs to university campus and office, although as we are talking about a scholarship, salary does not reach for much more. Also, my job will help me to complete my CV, this will give me chances and opportunities over other mates that have not worked for a company previously, or at least not for one of the biggest telecommunication enterprises in the world.

To end talking about the motivations that gave me the last push for realizing the project in Alcatel-Lucent, I will make a small introduction to what ALU is and what it represents, although I will talk about the company later in the document. Just state that Alcatel-Lucent is one of the worlds reference in the telecommunication field, it is the result of the union of two companies that had a lot of experience in this field, these are Alcatel and Lucent Technologies. With a great number of professionals working for ALU, the company operates over 113 countries [1] all around 5 different continents [1].

1.2. Objectives

Firstly, project objectives are mentioned, here we I will go through those objectives stated with my tutor in the company to accomplish in the six months of work. After this, professional and personal objectives are detailed.

1.2.1. Project Objectives

Probably at this point it is difficult to understand the project objectives I will state now. I say this as nothing has been explained yet, not the architecture neither the analysis, so maybe, because of this, some terms or components that I may mention when dictating these objectives will be difficult to map or consider in the system, but all of them will be sometime in this document explained and clarified.

The main objective to accomplish during the period I will be working in the project will be to help in the migration labour from the old version of the project to the new one. ALP2.0 is a platform in charge of managing and taking decisions over a series of events received from a complete telecommunications net, it is oriented to automating certain actions or incidences' requests for the integration of various technologies. These technologies are the following:

- Mobile Access (AM)
- Core Mobile: Core Switching and Packet Switching (CS/PS)
- Switching Fixed Voice (FS)
- Classic Transport (TR)
- IP/MPLS Network (IP)
- Core Fixed Access (AF)
- Security, VAS

I will be in charge of developing the organization of several agents responsible of automating processes in order to gather technologies correct functionality, concretely, those in charge of managing Mobile Access (AM), such as GSM or UMTS, as well as Switching Fixed Voice. This process is not simple, it includes the management, recompilation and organization of agents, alarms, commands and trouble tickets or incidences from the technologies mentioned.

Some of the information we should have obtained from Telecli in relation to all these agents, alarms, commands and trouble tickets has not arrive just because it does not exist. What I am trying to say is that Telecli developed high portion of the first version of this project without documenting some complex implementations. This fact adds on more complexity to the already complex

labour we have to commit for developing the second version of the project which labour is to automate all those functions that are not yet automated. Continuing with the promising version we inherited from Telecli, I have to say that it will not be easy to perform a good and well-structured organization, even less easy it will be taking into account that it also means understanding and commenting in order to make more clear some of the code which is written in up to 10 different languages such as Pascal, C#, C++, C, Java, etc.

Summarizing, the final objective will be to arrange a good organization plan in order to develop a managing labour over agents, alarms, commands and trouble tickets implemented by Telecli. Go over their code, organize it, document it, check what is missing, translate documentation so it can be used by any worker of the company at any other country, perform reengineering labours and end up performing good pieces of work that enable our Indian mates start unifying code related to agents, alarms, commands and trouble tickets so that the base of this second and well-structured version of ALP becomes real. Sometimes it is easier to understand objectives if they are listed as tasks to do, so these are the objectives I want to become real:

- **Main Objective 1**: Perform an organized and reasonable plan for the organisation development of the different elements (Agents, alarms, commands and trouble tickets) that take part in the core of the automation processes.

- **Main Objective 2**: Follow the stated plan and carry out the agents organisation, explaining clearly which are the reasons that invoke them and what measurements will they apply to solve conflicts that take place in Mobile Access and Switching Fixed Voice technologies.

- **Main Objective 3**: Go through the plan being able to gather all the necessary commands for executing required actions over the different elements that compose Mobile Access and Switching Fixed Voice technologies.

- **Main Objective 4**: Go through the established plan being able to manage all the alarms that may appear as a result of an incidence in Mobile Access and Switching Fixed Voice technologies.

- **Main Objective 5**: Follow the plan and organise the way in which trouble tickets will be managed in Mobile Access and Switching Fixed Voice technologies.

1.2.2. Professional & Personal Objectives

It is important to mention the three main objectives for getting involved into this project in Alcatel-Lucent. The first one is experiencing taking part into a very big project in which lots of countries and workers are involved, another aim is to try to make myself a place in an important company such as ALU in order to continue with this and other projects in the future, and last but not least, a very important purpose is to develop technical and social qualifications.

Now is time to comment about what are the advantages in terms of knowledge, experience and abilities acquired when working on an international project of huge dimensions. These characteristics are the ones I desire to gain or improve with this project, is my second step in the labour world and the first one in an important sized software project, so my expectations are no less than my ambitions and motivations. What I expect from a project of such a dimension and international expansion is learning from it, with this I mean gathering experience working on other methodologies applied for software development and from other people with different working habits and procedures. I will like to get immersed into international cooperation dynamism, being able to participate carrying out different project tasks closely with foreigners that work for the company as I do, but 10,000 km away. I sincerely think that this will give me the chance of meeting new points of view that in other circumstances and projects of other characteristics I would never be able to know.

The second but not last main motivation for getting involved in the project is due to the opportunities that it might give me in the future. With this I do not refer to the chances of finding other jobs away from Alcatel-Lucent once finished the degree, but to the possibility of ending as an ALUs indefinite worker. It is not a secret that companies trust on those workers that have learned and developed skills in the own company before doing it on others that hang in their CVs and from whom there is no reference at all. This, added to the actual status of the country, deeply trapped in the crisis that asphyxiates a considerable number of world leading nations, makes stronger the necessity of ensuring a job once concluded the university period. At this point comes the rhetorical question; what solution could be better than working in other projects for the company that gave me the first important opportunity once concluded university?

Last wish to that inspires me motivation to join this project is the fact of becoming better, improving and growing technically and socially. From my point of view, the experience is one of the most important facts to take into account whenever carrying out anything. Experience is knowledge, is training, training yourself to don’t trip several times with the same thing and learning how to do things that you have already done in half the time you spent. Definitely this is

one of my priorities, gaining technical and social experience, in order to be able to resort to it in future situations, and with it, solve problems that I will be face in my professional career and that nowadays I don’t know how to fight.

2. Why Alcatel-Lucent?

Reasons for thinking in Alcatel-Lucent for carrying out my thesis are multiple. Let's start telling a little bit about ALUs history as well as ALUs relevance on the telecommunication field and its importance in the world, and then we will talk about how they develop software in order to achieve their objectives.

Figure 1 – ALU Logotype

Alcatel-Lucent was born when two companies such as the French Alcatel and the American Lucent Technologies merged on the first of December of 2006 [2]. These two companies were also dedicated to the telecommunication field before the union. After they were merged, Alcatel-Lucent went through 9 difficult months in which losses became common, so some changes took place at the head of the company leaving Philippe Camus and Ben Verwaayen leading the company until the 1st of April 2013 [2]. Once these changes took place, the company started to obtain revenues and stability returned. From the 1st of April of this year the person in charge of the company is Michel Combes. Michel Combes has been previously Chief Executive Officer, Europe Region, of Vodafone.

Alcatel-Lucent main job is to provide telecommunication solutions to its clients; these are mainly service providers, but also to governments and other companies. It provides hardware and software as well as services. ALUs services do not finish here as it is also involved in other businesses different from the networking, for example, Alcatel Space is a reference constructor in satellite systems.

ALU is one of the biggest telecommunication enterprises in the world, has around 77000 workers [1] all around the planet and has huge amount of revenues. To manage some data, just in 2012 it made up to 14,4 billion dollar revenues [2] operating in 113 different countries [1].

3. Project organization

In order to preserve Alcatel-Lucent privacy, we will not mention the real name of the project, so from now on we will refer to it as “ALP 2.0” or “Alcatel-Lucent Project 2.0”, nevertheless, the project will be described as it is and all the qualitative and quantitative data revealed in this brochure will be entirely build up with real details. In the same way, the name of the telecommunication company with which ALU treats will not be revealed, instead I will refer to it as Telecli or Telecommunication Client.

ALP 2.0 is one of the projects in which we work currently in the company and is the following version to ALP 1.0. ALP 1.0 was developed by Telecli but sold to Alcatel-Lucent In June 2012. We can introduce ALP saying that is a composition of processes that allow automating the events management in order to manage a series of businesses for different networks. There is a main difference between ALP 1.0 and ALP 2.0, we want this last version to run over a solution development platform that we will call from now on “PORALP” or “Platform On which Runs Alcatel-Lucent Project”. We will discuss further on in detail about ALP 1.0 and PORALP, but now is time to introduce the project organization for ALP 2.0.

ALP 2.0 is a project to be implemented for sixteen different countries. These countries are Brazil, Argentina, Chile, Peru, Colombia, Venezuela, Panama, Guatemala, El Salvador, Nicaragua, Mexico, Spain, Slovakia, Germany, Czech and UK.[3]

Figure 2 – ALP 2.0 Expansion

3.1. Staffing organization

It is important to talk about the organization of the project, what roles will be accomplished inside the project, the different aspects that are covered by each role, and also how are these roles structured and positioned in order to draw an organization that ensures the project success.

The project staffing organization is crucial in every project, no matter the company or country of development, organization must be stated and accorded in order to establish roles clearly before starting working. Same happens in Alcatel-Lucent, deserved relevance is given to the staffing organization of the project as it is considered as the basis of any project. In ALU there are two project staffing organizations, these are the ALU Global Organization for software projects and the ALU Local Organization for software projects. Each of these arrangements has its roles clearly defined, this is what we are going to review now, we are going to examine in detail what are the responsibilities of each person in charge of executing every role in ALUs projects.

The ALU Global Organization for software projects is illustrated in the following schema [6]:

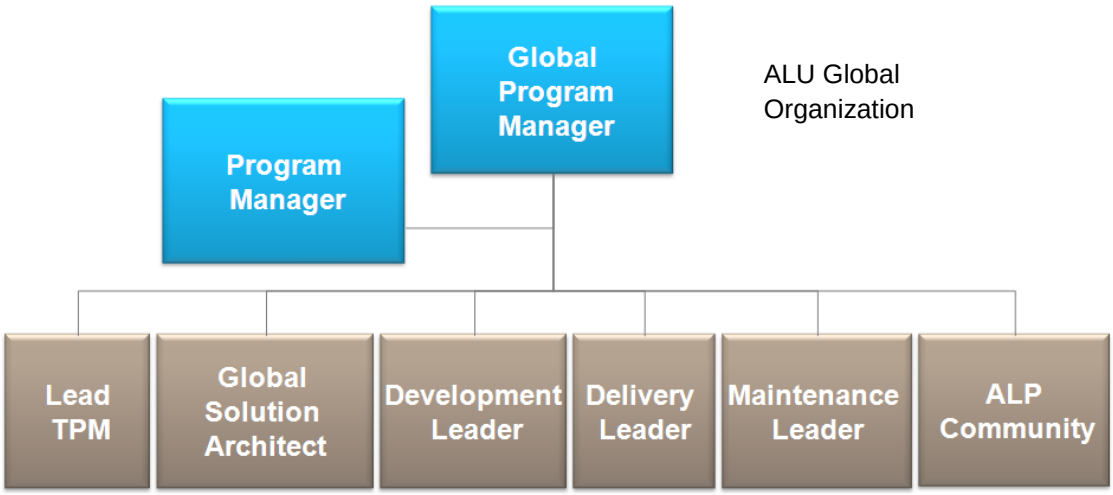

Figure 3 – ALU Global Organization

Figure 3 allows us having certain idea about how the organization is arranged and distributed, but we should describe each role in order to be aware of what specific tasks every person carries out. A full description of each role presented in the ALU Global Organization Diagram is provided bellow [6]:

Global Program Manager:

- Project responsible
- Platform implementation responsible
- Single Alcatel-Lucent interface for the customer and all project stakeholders for the contract

Program Manager:

- Global coordination and milestones follow up
- Master project plan ownership
- Assures consistency for all the countries

Lead TPM or **Lead Technical Manager**:

- Manages the implementation of all the technical aspects of the Customer Project, in terms of feature content, delivery date and quality of the technical solution, from offer preparation through deployment activities and customer acceptance, being fully accountable for the overall solution including the integration of all the sub-solutions with focus on the interfaces

Global Solution Architect:

- Captures the critical inputs of stakeholders, and translates them into effective requirements and solutions
- Responsible for
    - Knowledge transfer process
    - Architecture solution definition
    - Initial country surveys
    - Consolidation of functional and non-functional requirements

Development Leader:

- Responsible for the activities of the software development function, in terms of feature content, delivery date and quality
    - Porting operating rules to the new platform
    - New developments and adaptations
    - Test validation

- Assures adherence to development processes

Delivery Leader:

- Responsible for integration of the solution
- Defines consistent deployment process and guidelines for the whole countries
- Supports and monitors country implementations

Maintenance Leader:

- Provides centralized remote technical support for the solution with defined respond, restore, and resolve turn-around time objectives based on severity of the problem
- Supports to local maintenance teams

ALP Community:

- Responsible for relationship with ALP Community
- Definition of processes for interworking, consistent rules development and further acceptance
- Proactive participation in the Community being their advocate

The other staffing organization is the ALU Local Organization for software projects, there is one for each OB and it is illustrated in the following schema [6]:

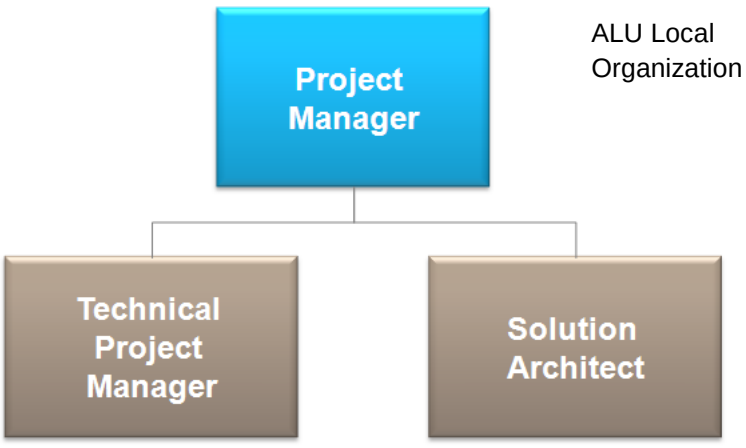

Figure 4 – ALU Local Organization

A description of each role presented in the ALU Local Organization Diagram (Figure 4) is detailed bellow:

Project manager:

- Project responsible for all local activities
- Directs local project plan execution
- Coordinates with global teams

Technical Project Manager:

- Manages the implementation of all the technical aspects of the Local Project
- Coordinates with global team

Solution Architect:

- Manages functional requirements for the local project
- Collaborates with global teams during initial survey
- Supports the local bids

3.1.1. My position inside the organization

I am currently working in a team, directly for the Global Solution Architect. The team is working towards achieving a well-structured base architecture, taking as starting point worked performed on the first version. Some of the jobs we are in charge for are migration labors, picking up pieces of the old architecture and putting them together in an organized way in order to build up a structured system, with an organized and clear architecture.

Migration labors are extremely important, to be honest, there is a slight disorganization in relation to documents and pieces of code of the last version. Me and my team, we are in charge of collecting those elements essential for migration labors and developing a new organization for them. Never mind, this will be explained further on, the thing is that my position is inside a team, dedicated to migration of automation elements from ALP 1.0 to ALP 2.0. This team is located inside the System Architecture team, although there exists other teams working for other elements migration and inside other teams such as the development one.

3.2. Project Planning

It is important to clarify the work structure and leave every task and phase of the project correctly placed into a clearly defined structure. For this we have divided the project ALP 2.0 into nine phases. Each of these phases has the same importance as any other, as they are essential and without a single phase, it would not be possible to conclude ALP 2.0 project. For each one, we will define its role and responsibility inside the project, as well as the required inputs in order to be able to accomplish their particular objective. It will be also mentioned the output expected and the required resources to meet the objectives.

The nine chapters established for building up ALP 2.0 are the following ones [4]:

Unit 1: Country Assessment

Gather information from each Country (OSS/BSS Systems Map, Impacted ecosystem, Service Restoration Processes identification, Technology Areas covered, Equipment Families supported.) Afterwards, consolidate the information retrieved from Knowledge Transfer and Country Assessment, as input for the rest of the project. Finally generate and deliver country based offers for SEP Implementation.

- **Role/Responsibility:**
  - Assessment Data Capture
  - Assessment Data Consolidation
- **Input/dependencies:**
  - Telecli Templates filled by Telecli OBs
  - Alcatel-Lucent template filled by Telecli OBs
  - Consolidation Assumptions agreement and commitment from Telecli OBs
- **Outputs:**
  - Country and Global Data Result consolidated
  - Priority List definition
- **Resource/Profile Gaps:**
  - Not applicable

Unit 2: Requirements & architecture

Collect all requirements to accomplish with the system construction. Fill up the correspondent documentation with every kind of necessary requirements, from architecture requirements until security ones. In reference to these requirements and to the system necessities, perform those architecture documents useful to help developers build up the system and to set up the architecture organization the system is going to follow.

- **Role/Responsibility:**
  - System Requirements
  - System Architecture
- **Input/dependencies:**
  - ALP 1.0 Documentation
  - PORALP Product Description
  - PORALP Features Roadmap (detailed)
- **Outputs:**
  - RDD & RTM
  - SAD & HLD
  - Actuation Modules Description
- **Resource/Profile Gaps:**
  - Solution Architect
  - Domain Architect

Unit 3: E2E Solution SW Design, Policies & Interfaces

Provide a E2E solution definition describing important subjects such as architecture and interfaces that will be provided.

- **Role/Responsibility:**
    - Detailed E2E Solution definition, including SW architecture, policies, process dimensioning and main SW interfaces
    - THE “GLUE” between layers
- **Input/dependencies:**
    - SDD, System Requirements, Architecture & HLD
    - ALP 1.0 IPR documentation & Code
    - PORALP Documentation & Workshops
- **Outputs:**
    - Detailed E2E Solution definition, including SW architecture, policies, process dimensioning and main SW interfaces
    - Actuation Modules Development Environment Definition
    - Actuation Module detailed deployment procedures
- **Resource/Profile Gaps:**
    - Solution/Software Experienced Designers

Unit 4: Actuation Module Development

Achieve Agents construction, elementary part of the automation process. Provide their implementation and configuration in the new platform, leading to a working solution of the Agents automation process.

- **Role/Responsibility:**
    - Platform, tables and configuration consolidation
    - Agents Design and Development
- **Input/dependencies:**
    - ALP 1.0 Agents Documentation and Code
    - Platform and Core Libraries
    - Agents libraries compiled in Linux
    - Communicators API Interface
- **Outputs:**
    - Agents development Environment for TLC
    - Agents running in new platform
    - Consolidated Platform files and tables
- **Resource/Profile Gaps:**
    - Agents Designers
    - Agents Developers

Unit 5: PORALP Based Platform Implementation

Achieve the design and implementation of the necessary Adaptors/Communicators, all inside the software package that provides the correspondent views and manuals for the Adaptors treatment.

- **Role/Responsibility:**
  - Adaptors/Communicators Detailed Design
  - Views, Adaptors/Communicators Implementation
- **Input/dependencies:**
  - Adaptors/Communicators REQ/ARCH/HLD
  - External Interface Specifications for Communicators
  - Views REQ/ARCH/HLD
  - Agent Service Layer Interface Specification
- **Outputs:**
  - SW Package (including Views + Adaptor/Communicator)
  - Installation/Configuration Manual for Adaptors and Views
- **Resource/Profile Gaps:**
  - 3 Designers

Unit 6: ALP 1.0 Reuse & System tools

Achieve platform already running and all necessary tools in order to install and configure it.

- **Role/Responsibility:**
  - ALP 2.0: Code reusability and system tools
- **Input/dependencies:**
  - ALP 1.0 Code/libraries and tools.
  - PORALP documentation about system tools
- **Outputs:**
  - Core platform running in Linux/MySQL
  - System tools :
    - SW Installation
    - SW configuration
    - O&M
- **Resource/Profile Gaps:**
  - 3 resources to develop system tools.

Unit 7: Fast Track Integration Path

Reach a first integration before the formal one, configure it for customer demo. Provide tests for this initial fast track.

- **Role/Responsibility:**
    - First Integration Line makes sure a minimum acceptable quality before formal integration and verification.
    - Technical integration solutions for first integration activities
    - Responsible for internal/customer demos
- **Input/dependencies:**
    - ALP 2.0 SW Packages
    - Installation/configuration procedures
    - ALP 1.0 IPR doc, code & access
- **Outputs:**
    - Complete ALP 2.0 SW package, sanity tested for formal integration/validation
    - Test Reports & Change Requests
- **Resource/Profile Gaps:**
    - 2 Experts Solution designers/testers

Unit 8: Integration / Validation

Final integration of the system solution and correspondent validation for system completeness. Final solution, ready to distribute around different countries taking part in the project.

- **Role/Responsibility:**
  - Formal Integration & Validation of the Solution
  - Readiness Authority
- **Input/dependencies:**
  - All previous phases documentation
  - ALP 2.0 SW load after Fast Track Integration Path
- **Outputs:**
  - Final Solution Packages Delivery
  - Integration & Validation Test Cases
  - Change Requests
  - Readiness reports
  - Release Notes
- **Resource/Profile Gaps:**
  - 2 Solution/Software Testers with SW debug capabilities
  - Rest of resources coming from development teams

Unit 9: Deployment Team

Develop product diffusion strategy and perform final tests.

- **Role/Responsibility:**
  - Define/Execute global strategy for delivery
  - Support local ALU units delivery
- **Input/dependencies:**
  - System SAD/HLD/AM description
  - Installation/Configuration Manual
  - SW package.
- **Outputs:**
  - HLD/LLD/Tests docs per country
  - PORALP Platform/AMGs delivery per country
- **Resource/Profile Gaps:**
  - 2 people per country to support deployment/maintenance
  - 1 person per country in global team

3.3. Time and Milestone Planning

ALP still requires of a lot of work in order to be ready to present a final product, indeed the project is just starting and it is planned to be ready in for 2019. So we have outlined a plan with the objective of guiding future steps and tasks towards meeting all requirements in the stated date limit [4].

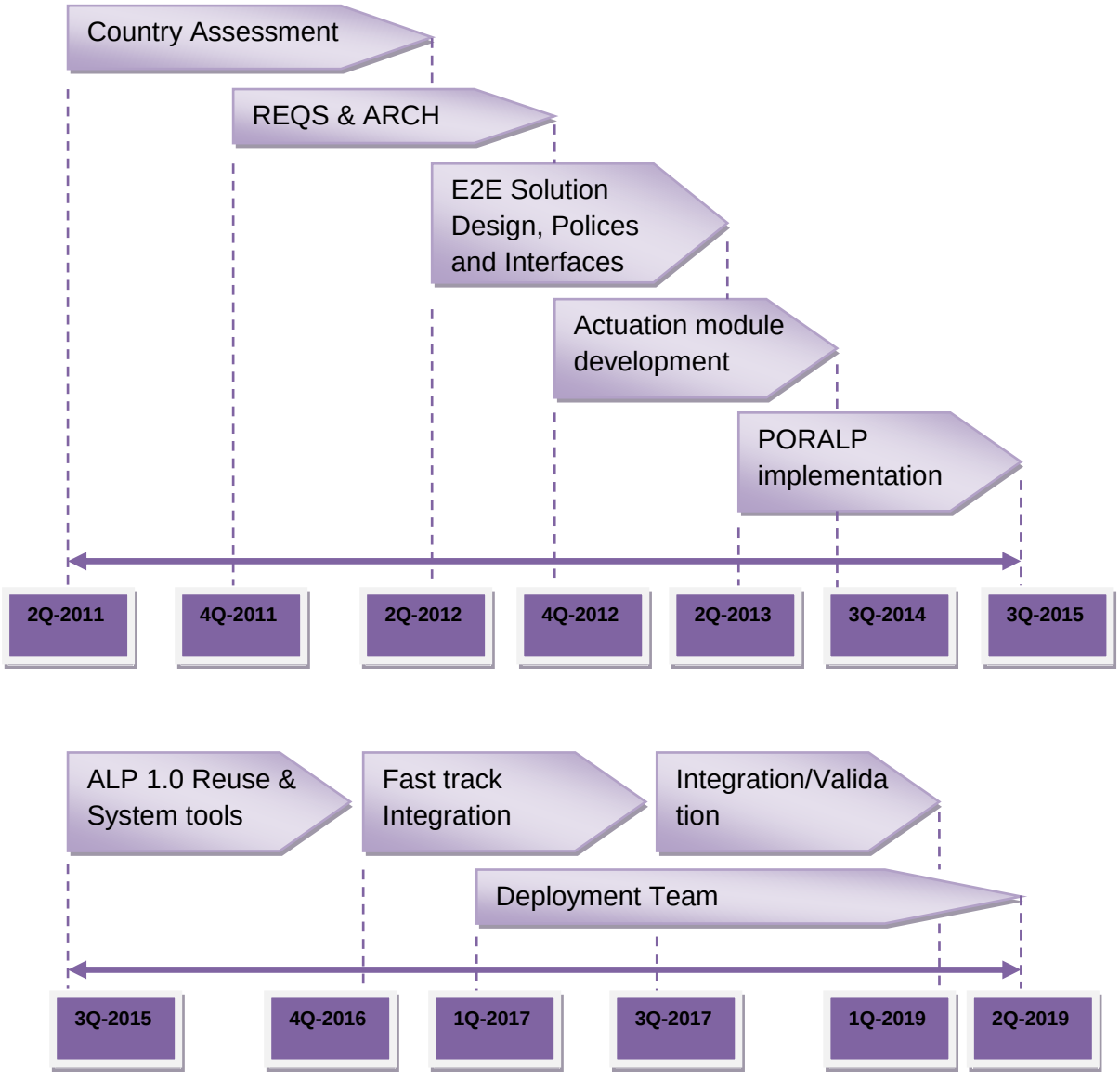

Figure 5 – Global Planning

We cannot say this plan (Figure 5) is always followed unit by unit at the same rhythm and not starting unit "x+1" before finishing unit "x". The reason for this is quite simple, although the idea is to follow the plan (and somehow it is followed), it is not possible to do it in a perfectly coordinated way, as there are

always teams in charge of some job that is performed faster than others for which other teams are responsible, so some groups will finish their job contained in one unit before others and so they will move to the following unit.

Is for this that we are currently working between two units, the third and fourth one, establishing the last requirements, designing the architecture, designing and consolidating the software structure, gathering agents and designing and implementing others, recollecting documentation and documenting other things that were received from Telecli without documentation at all.

3.3.1. My timeout and milestone planning

ALP2.0 is a huge project in which there are lots of workers involved and currently working for. A small section of these workers, my team, is working on the technologies organization. This is one of the most important things to be finished during the following two years, the organization of the agents that are in charge of the technologies for which ALP 2.0 is going to be developed. Inside these technologies there is also a priority stated, some of them are more urgent than others and therefore require to be structured before. Bellow we can see the managing and organization priority for these technologies:

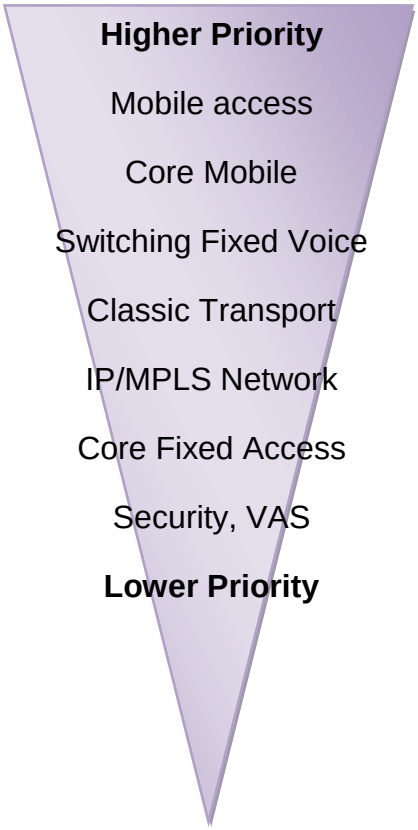

Figure 6 – Tech Priorities

The timetable for the organization consolidation of agents, alarms, commands and trouble tickets of these technologies shown in the figure is the following one:

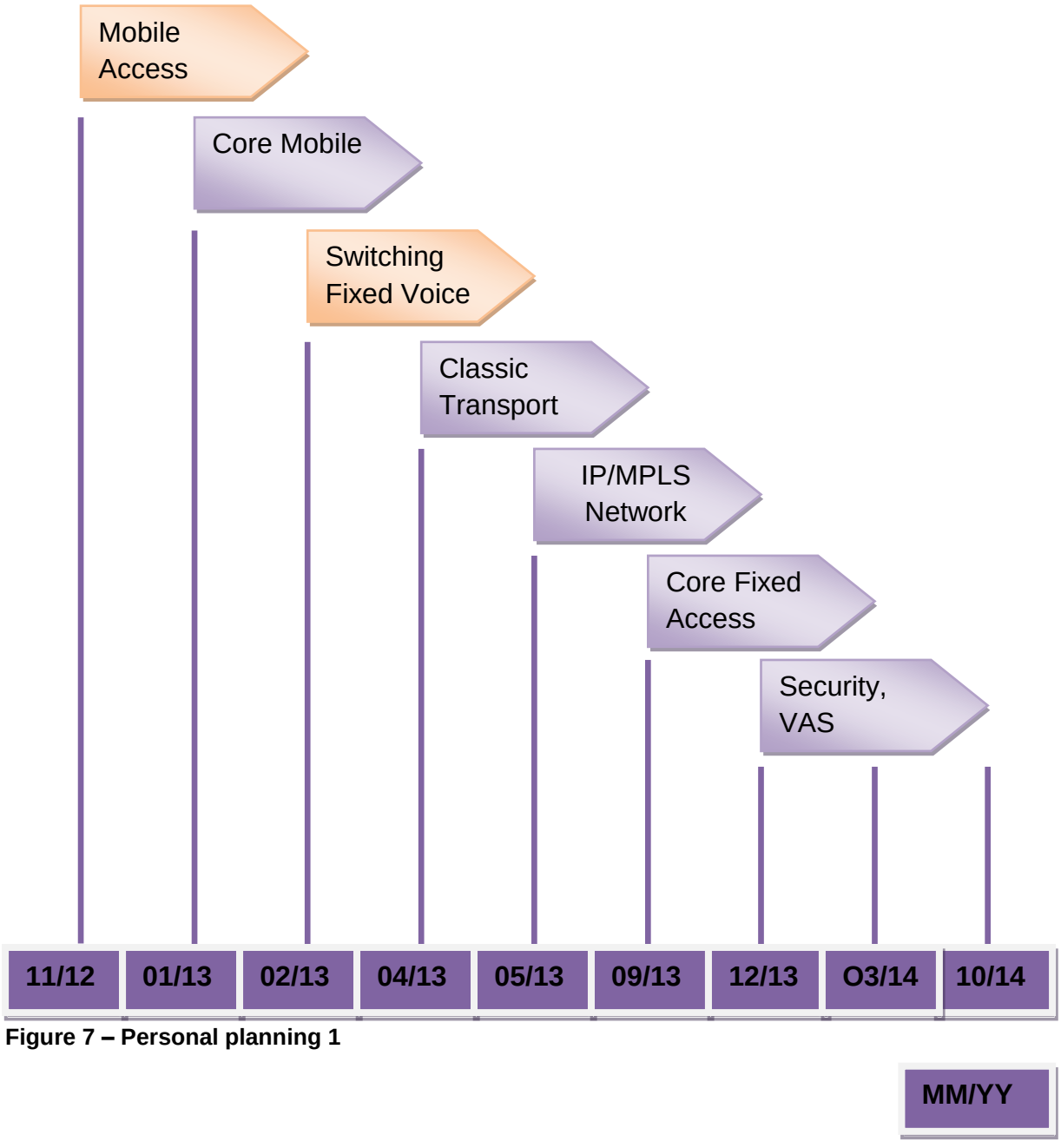

Figure 7 – Personal planning 1

We can distinguish two of the technologies drawn in Figure 7 situated above are colored in orange, these are the ones where I will be working. The plan fixes with my working months at Alcatel-Lucent, so I will dedicate my time to carry out these work combined with other translation and documentation work I am assigned in the company. But we can get into a more detailed planning of my work:

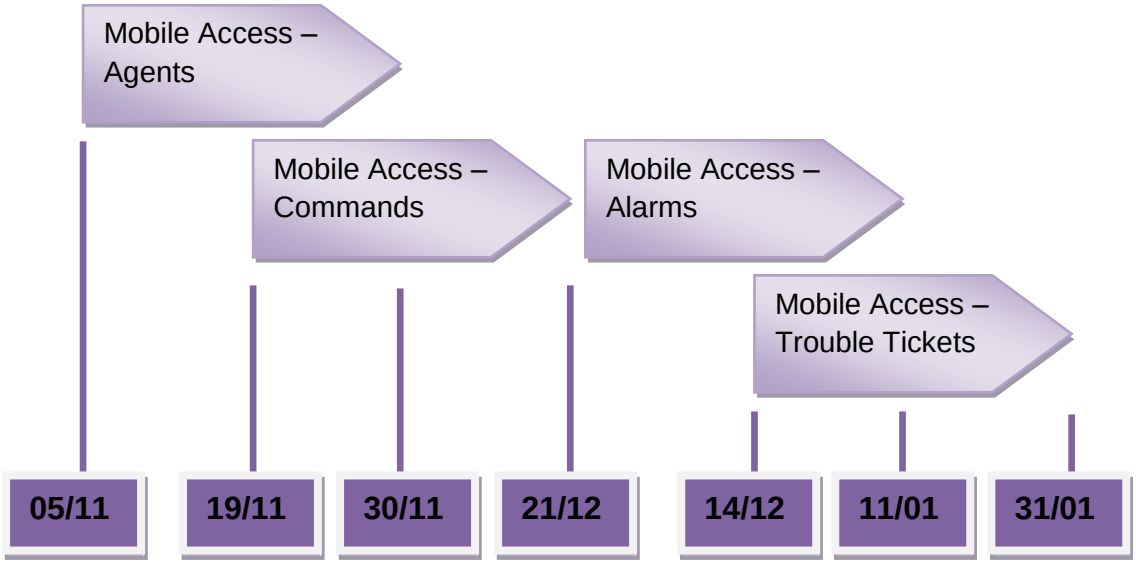

Figure 8 – Personal Planning 2

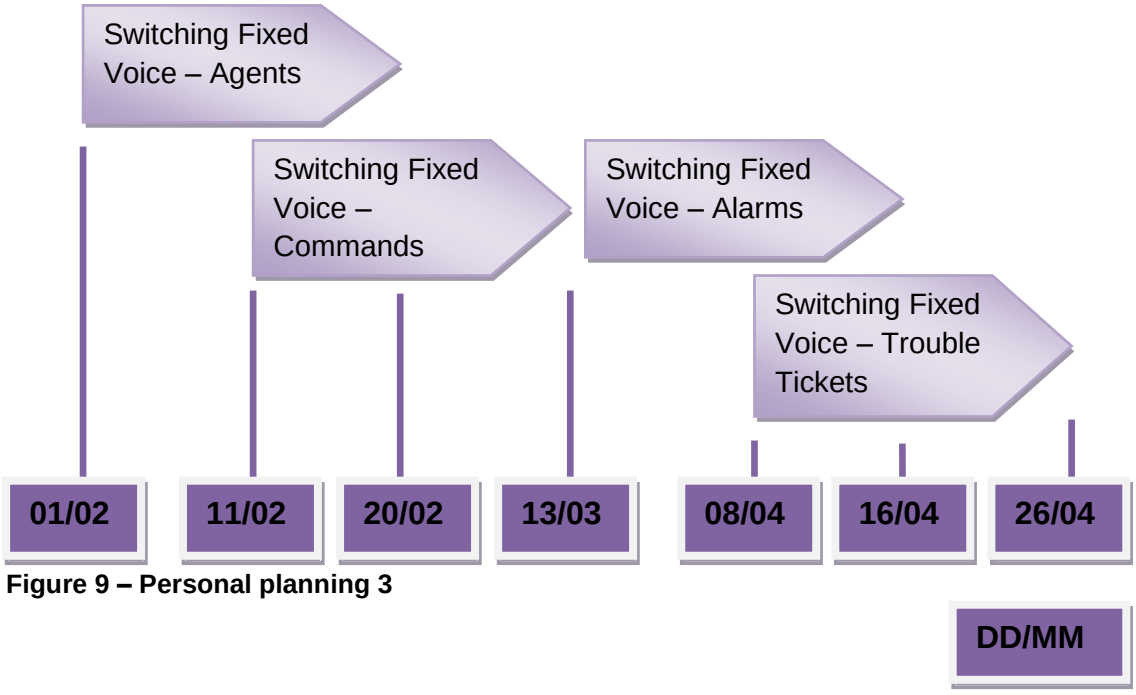

Figure 9 – Personal planning 3

3.4. Resources estimation

In this section, project costs will be shown and divided into type of costs. I found especially interesting those costs that had to do with my work in the company, these include material costs and personnel costs.

Material costs

Material costs can be divided into fungible costs and inventoriable costs. These first ones are those that are consumed with its use.

Fungible costs:

Material	**Approximated cost**
Paper	100€
Toner	100€
Water, electricity and building costs	200€
Total	**400€**

Inventoriable costs:

Material	**Approximated cost**
Computer	500€
Server	6,000€
Printer	500€
Scanner	200€
Telephone	100€
Total	**7,300**€

Personnel costs

This is easy to compute as we just have to take into account my costs, this means just one worker's salary:

Personnel	**Approximated cost**
Federico Traspaderne Figueroa	600€/month * 1,28 SS * 6 months= 4,608€

We should take into account, that it is a scholarship, and scholarship contracts are exempt of IRPF. So the total cost that the company will pay for my services will be the addition of all this costs plus an approximated 15% of indirect costs that we should also take into account.

Total cost

Type	**Cost**
Material (Fungible)	400€
Material (Inventoriable)	7,300€
Personnel	4,608€
TOTAL (Without IC)	12,308€
Indirect Costs (15%)	1,846€
TOTAL (Without Management expenditure)	14,154€
Management expenditure (8%)	1,132€
TOTAL (Without VAT)	15,286€
TOTAL (VAT included)	**18,496€**

4. Project status

4.1. Precedents

We previously mentioned ALP 2.0 is a project that improves ALP 1.0 functionalities. ALP 1.0 was developed by Telecli, a well-known broadband and telecommunications Spanish provider. Alcatel-Lucent obtained the rights over ALP and all to do with the project when it was purchased in June 2012.

ALP 1.0 is a composition of processes that allow automating the events management in order to manage a series of businesses for different networks.

ALP 1.0 basic characteristic is the use of socket communication. ALP platform is composed by a group of processes and configuration files, and at last, the web environment, here is where the whole system is configured and supervised.

The main activity is to describe ALP 2.0 system as well as its architecture and everything related to the project, however, it is very important to consider ALP 1.0 architecture and make a brief description of it as it is the basis of the following version.

Here, we can see a schema that describes ALP 1.0 platform logical architecture [7]:

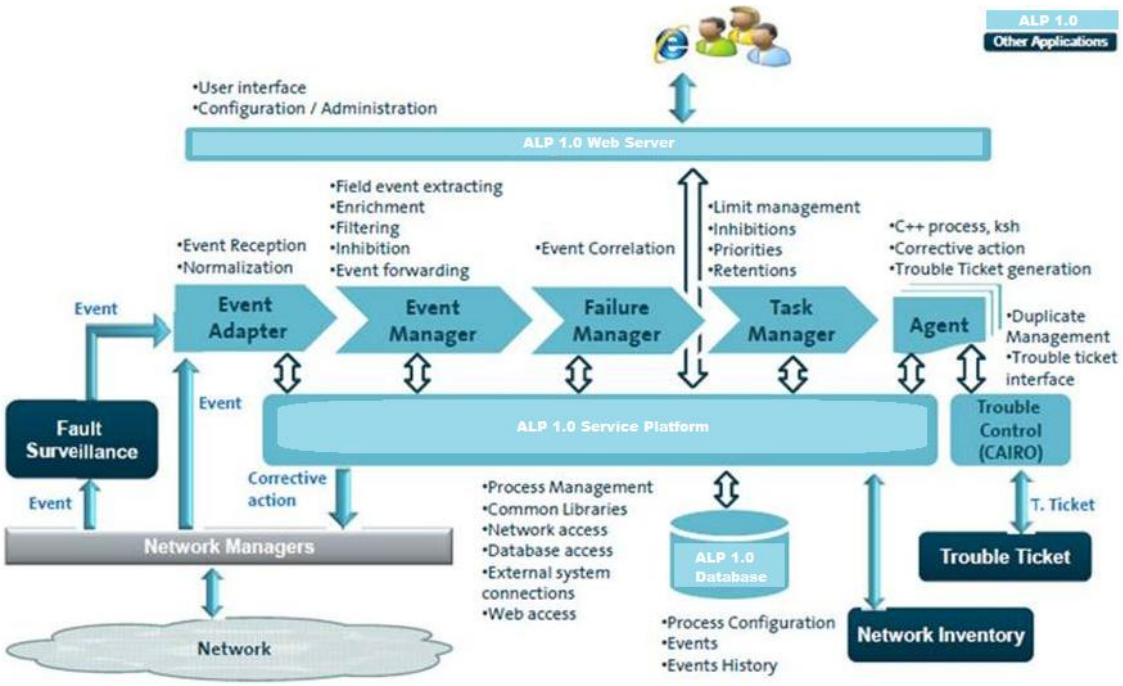

Figure 10 – ALP 1.0

Figure 10 outlines the high-level architecture of the ALP 1.0 system. Basically, we must distinguish two main functionalities of ALP 1.0, the event processing and the ticket processing scenarios. An alarm originates from the Network (bottom left of diagram) and is either caught by a Fault Surveillance system or flows directly into the ALP system. The Event Adaptors accept the alarm stream from the Fault Surveillance system or from the network manager. The event is then minimally processed through the Event Manager with enrichments and discard rules and then more heavily processed by the Failure Manager for correlations. Once determined a task is created within Task Manager which manages (prioritizes, limits, administers) the resulting action via Agents. The agents in turn interact with the appropriate network manager/element or application (e.g. Trouble Ticketing application) to affect the change necessary.

Telecli identified a set of problems in ALP 1.0 that ALP 2.0 is in charge of solving. The following list is not exhaustive but gives an idea about what are some of the problems ALP 1.0 has or facts that could be improved:

- There are more than 1500 agents deployed without a “common” internal structure.
- Automatisms are created in C, Java, C#, Pearl, C++, ksh and python by each Telecli Business group based on “skill” availability.
- Platforms change their behavior based on “plain text” files used as parameters.
- There are links to external DB, with direct access to tables, not using services. Not being the owners of that external DB, any change decide by the owner means that the agent doesn’t work anymore without apparent reason.
- Automatism logic is distributed, among agents, system parameters, layers, making difficult to understand, document and follow the logics.
- Lack of control on Agents execution (alive, hold, stacked, blocked, fine) and statistics Number of Sites.

4.2. Project work status

4.2.1. Next Step

Taking a look back to section 2.2 where the project planning was specified, we can determine in which phase we are currently working in the project. The most correct thing to say is that we find ourselves between unit 3 and unit 4, trying to achieve the correct union between different layers of the architecture (the architecture will be described further on) and managing ALP 1.0 code with the objective of migrating some of its functionalities and developing the agents. The main objective now is to consolidate the new ALP platform, concretely, the jobs to be done in this following quarter of the year are the following [4]:

- Recompile ALP 1.0 for PORALP
- Migrate ORACLE tables to MySQL
- Migrate ORACLE API calls to MySQL API calls
- Unique GUI based on PORALP
- Modify “ENRUTADOR” in ALP 1.0 to launch PORALP Agents
- Core functionality to Migrate. Trouble Ticketing Handler
    - Identify the Country specific TT systems to integrate
    - Identify the Interface specifications for each of them
    - Create Communicators for each of them
- Core functionality to Migrate. Storage
    - Common Webservice Specification
    - Create Communicators for Common Webservice
- Agents and Event Adapters
- Choose the Agents and Event Adapters to migrate or to add
- Migrate/Develop the Agents and Event Adapters identified
- Administration tools
- Deployment configuration definition

4.2.2. Achievements, Difficulties and Delays

Obviously, we can talk with plenty of knowledge about what we have already achieved and about what difficulties we found as well as the delays we are suffering. Next episodes relate these facts.

4.2.2.1. Achievements

These is what we have achieved so far, the most important steps we have completed in the way to build up ALP 2.0 [4]

- Team fully functional
- IPR knowledge transfer completed
- Assessments done except to Germany & Czech
- Country Consolidation Analysis done and ongoing
- Continuous Support to Telecli and Local teams in several areas (keep ongoing)
- Initial list of requirements available (with mapping to PORALP)
- Solution Architecture and High Level design completed
- Solution Architecture Workshop done with Telecli , including phase delivery approach
- HW configuration for the solution defined
- Detailed Mobile Specification produced and under completion with the OB's together with the local teams (4 countries validated)
- DD documents for Communicators (TT, Event, Storage & Actuation), Task Management
- Netcool, NectAct, Cramer and Clarify Communicators dev. Ongoing
- ALP GUI L&F and Navigation prototype ready for discussions with Telecli
- ALP R1.0 code 100% ported to Linux
- ALP R1.0 DB consolidation analysis available
- ALP R2.0 Alarm processing load (linux, mySQL) sanity tested

- Platform consolidation done for 2 AMs of mobile access, +2 ongoing

4.2.2.2. Difficulties

In the way, we have found several difficulties that lead to important delays, some of these difficulties happened due to lack of information and documentation of the first version of the project developed by Telecli. This miss of documentation caused people working on the project to make a pause and work to build up this missing documents and information on the project. The difficulties found are shown below:

- Late, lower quantity & quality documentation than expected on ALP
    - Impacts the work of all teams. We need to look in the code itself.
- Significant amount of documentation IPR work done by ALU
- IPR documentation still needed to be produced for the offers and for AM specs work.
- Key and # of profiles staffed (language is also an issue)
- Several rounds required after the assessment is done to complete/verify the required information
- Significant extra work required in the assessment phase on key profiles.
- Significant support required to contribute to the offers and keep on working with Telecli.
- Late and Lack of sufficient information/loads from PORALP 6.0 to define/develop the solution
- Some Vendor protocol specs not yet available, NDA in signature process.
- No documentation on the agent design, nor its libraries, nor sufficient guidelines on how they were built

4.2.2.3. Delays

Difficulties force a solving process which causes delay on achieving the principal objective, the delays we suffered are the following:

- IPR documentation incomplete
- Assessments for Germany & Czech Republic
- Next definition level on logs, production aspects, security, deployment procedures.
- System E2E Design/SW policies aspects not totally covered
- Stable Communicator List, Specifications, Sample Data
- AM's development work

4.3. Tools

ALP 2.0 project makes use of lots of tools, all of them essential for its future working. I can now think about development tools, documentation tools or other indispensable equipment, but in this chapter we will mention and debate about the use of PORALP, as base platform for ALP 2.0 running.

4.3.1. PORALP

PORALP is an adaptable rapid-fire solution development platform that enables service providers and enterprise clients to quickly and easily roll out new services, implement new technology, and optimize their network operations.

PORALP addresses common issues faced by our customers, such as

- System Integration – need to manage integrations between applications (Off-the-shelf and custom)
- Process Automations - need to augment existing applications (Off-the-shelf and custom)
- End-to-end Monitoring of Services - need to implement monitoring solutions for services and applications
- Consolidated Visualization – need to leverage many visualization into a singular effective presentation

Alcatel-Lucent uses PORALP to deliver established solutions as well as to develop customized applications.

4.3.1.1. PORALP Architecture

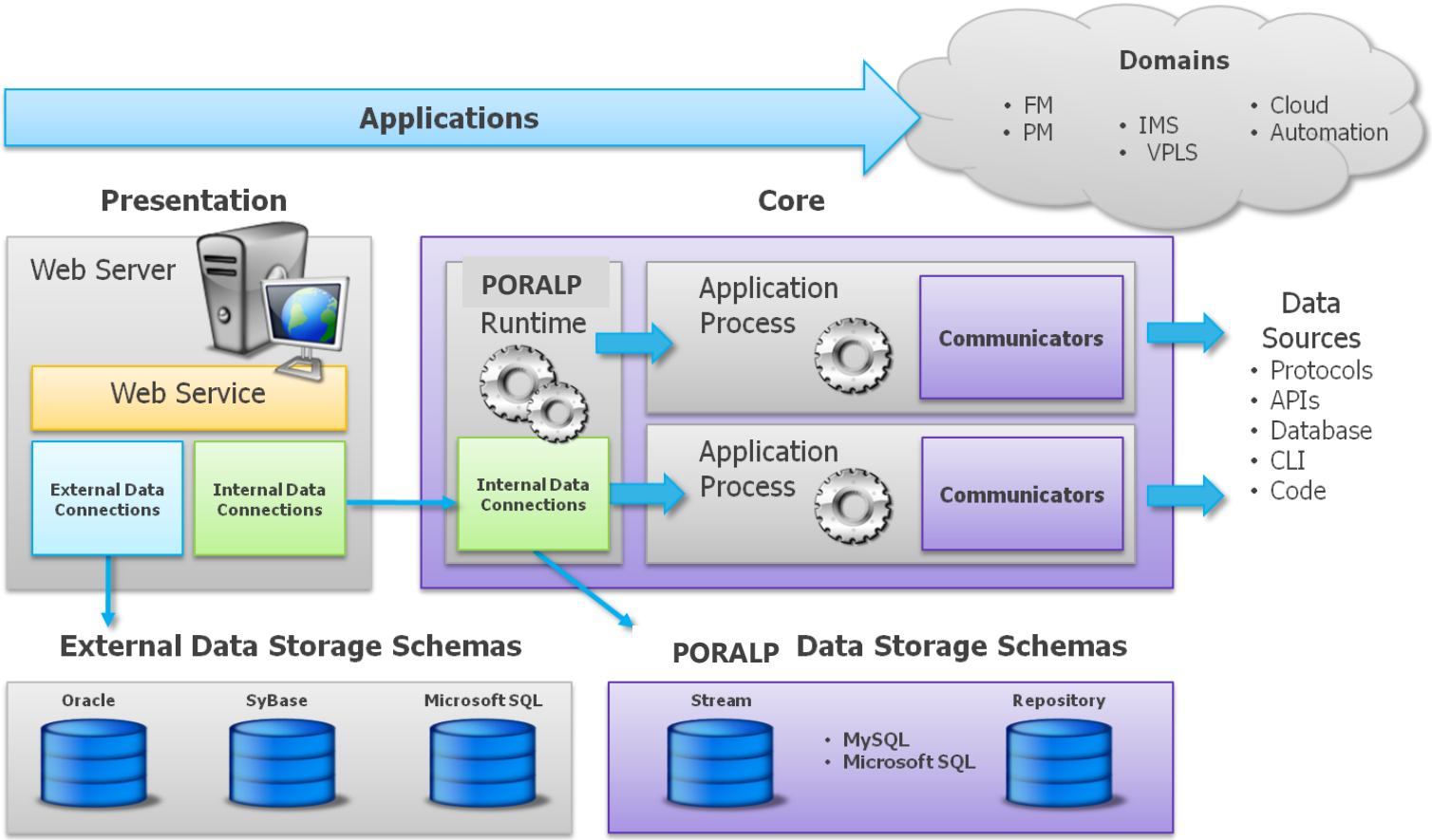

Figure 11 – PORALP 1

PORALP Architecture key components [5]:

- Communicators (interfaces)[5]: Components for 2-way interfacing with external elements, leveraging multiple technologies (SNMP, SOAP/XML, (S)FTP text file, SSH CLI parsing, DB, ...) and any open API; ever-growing re-usable template library; any external element, not just Alcatel-Lucent hardware; Core out-of-the-box Communicators, and Custom Communicators built by Alcatel-Lucent Delivery teams and Customers.

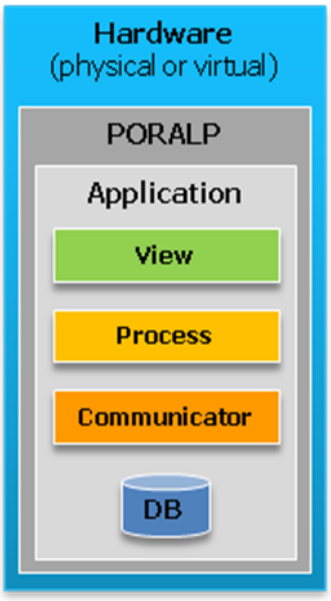

Figure 12 – PORALP 2

- Processes (Business logic) [5]: Use data (DB-stored) from Communicators (or send data to them) and perform calculations on it or any treatment (Threshold-crossing alarm creation, alarm filtering with name lookups, stateful flow management, etc.). Any operation logic can be saved in parameter driven Steps for re-use (drag-and-drop assembly of Steps from library). Expression power: algorithmic (with programming language) and visual (graph of Steps). Can save data in DB as Metrics in Streams (DB construct holding a flow of data). Can be scheduled or executed based on events received from external API or user activated via the Portal

- Views (GUI) [5]: Graphical front-end, can be nested (hierarchical) for navigation ,contain Modules which can be bound to Streams for real-time animation (GUI is refreshed whenever data is updated in DB Streams: latest value, moving averages, etc.)

5. ALP 2.0 Project

5.1. ALP Community

I consider the best way to start this section is to describe the ALP Community. It is important to start mentioning the first three and most important requirements or objectives of the ALP Community:

- Establish an **Agent Development Community** based on automation of network monitoring and operation, with a Global Scope.
- It will be a **governance model** that will support the transformation and globalization to be achieved in operations from the automation of network monitoring activities.
- Set-up the **Agent Development Model** that the Community should comply.

The management of the ALP environment is given special importance, ALP Community will allow to share, manage and reuse knowledge:

- Network. OBs have specific network configurations and common technologies.
- ALP. ALP will be implemented in all countries, allowing management of networks under a single platform.
- OBs Technical knowledge is distributed. Each OB operators have the knowledge to manage your network.

In order to achieve all these objectives, in Alcatel-Lucent it is believed that there are some rules to be followed and to be respected always. Following these rules it is ensured that every person involved in the project is moving towards the same aims and cooperating between each other. These rules are non-written rules, with this I mean that they are somehow moral rules to help the project evolution, they are simple concepts that every person taking part in the project must bear in mind.

Figure 13 is a drawing illustrating these rules I am referring to:

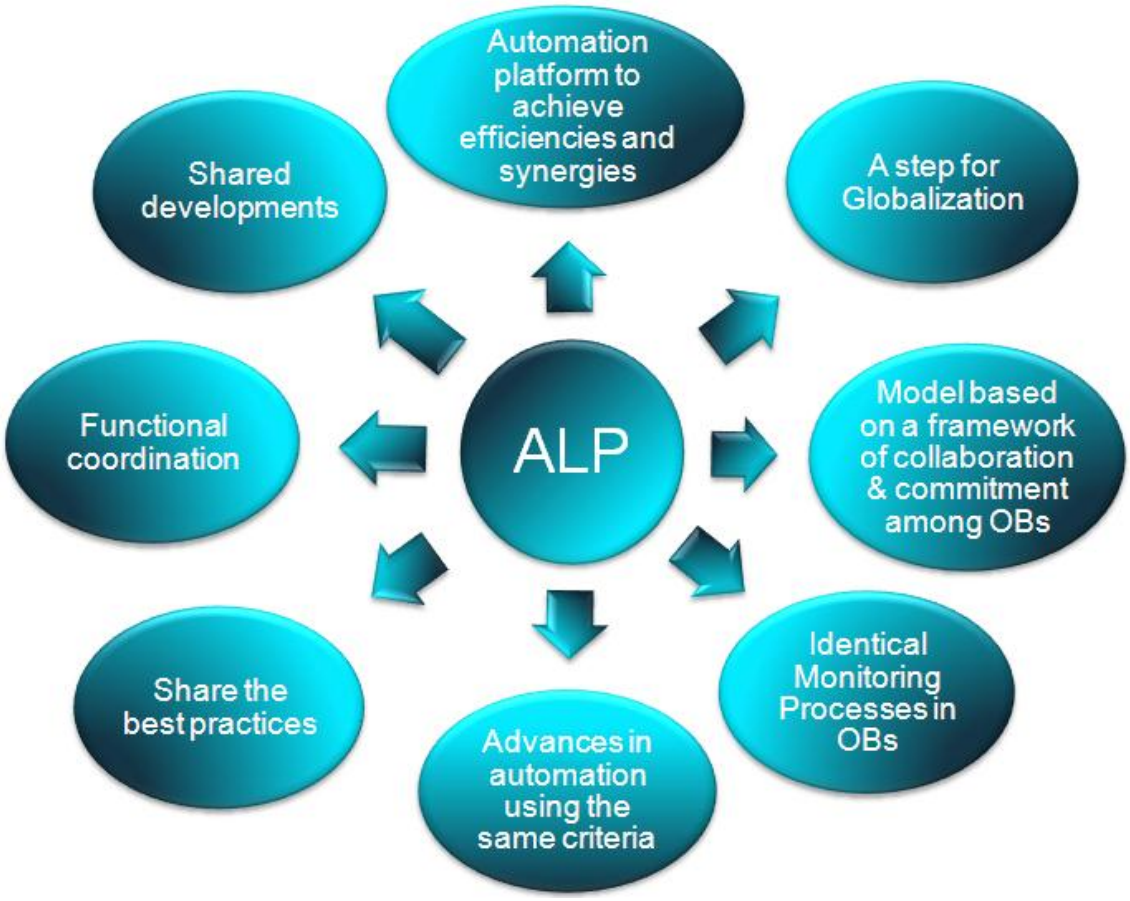

Figure 13 – ALP Community 1

In order to gather everything, it is important to design a functional unit. This unit helps to be able to support the automated model in the group responding to the demands of the OBs globally, captures new opportunities for efficiency in the group and connects the group in an environment of collaboration and commitment [3].

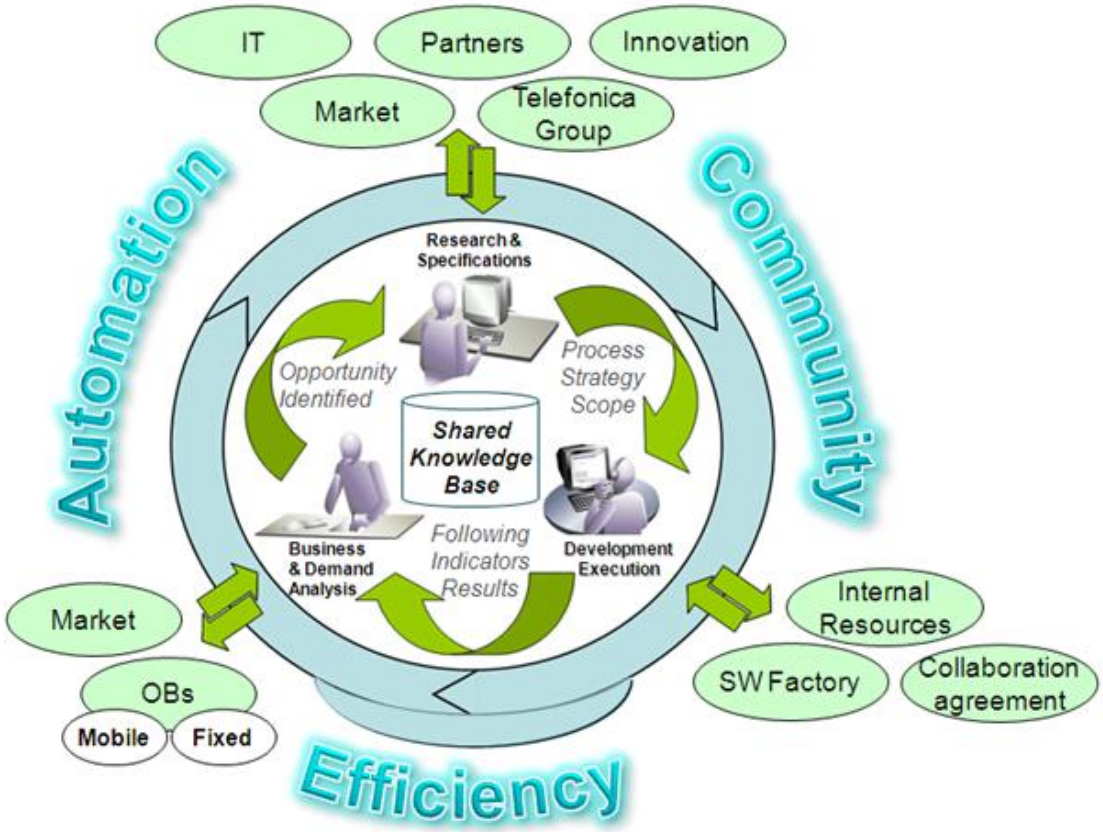

Figure 14 – ALP Community 2

5.2. ALP functionality introduction

“Automation of the network supervision activities”. These are the words that better describe ALP, a system capable of accomplishing several functionalities all together in order to offer quality in the automation of network activities.

With ALP the previous flow of actuation on events/alarms is potentiated by the supervision automation, reducing the manual and repetitive activities and maximizing the quality of the O&M process. ALP achieves this by realizing an expert monitoring of the network elements and introducing a two-way dialogue with these elements, by crating trouble tickets for incident management and by performing other automatic operations and event correlation.

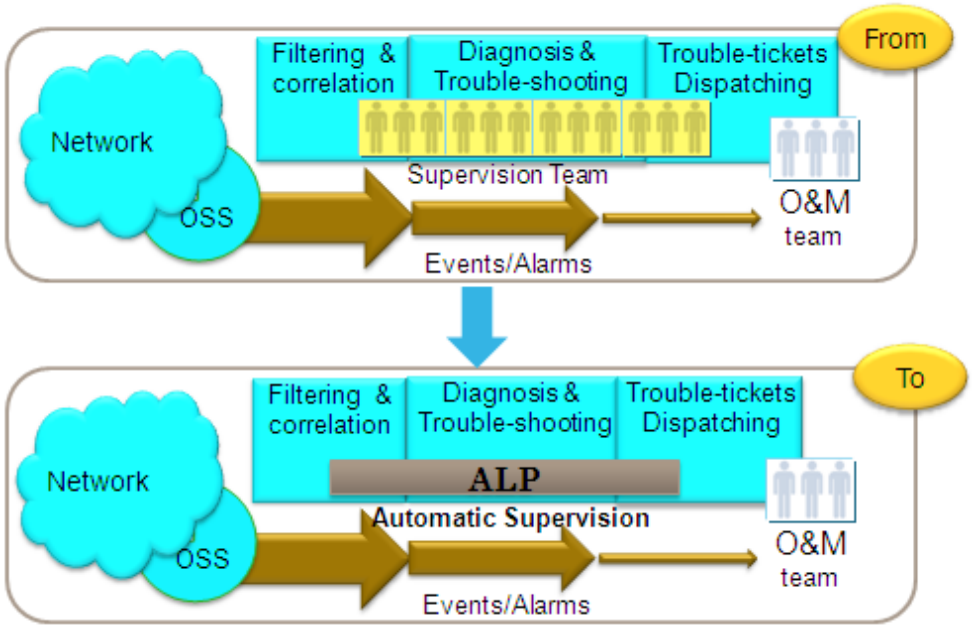

Figure 15 – Summary

5.3. ALP 2.0 improvements on ALP1.0

As we have already mentioned a couple of times, ALP 1.0 was developed by another company, Telecli. Alcatel-Lucent intends to migrate the ALP 1.0 design to a platform to achieve two things [3]:

- Deploy the new/improved version (ALP 2.0) to the various business units within Telecli divisions within Europe, South and Central America, and the United Kingdom.
- Resell the product to other customers globally.

The goal of the ALP platform is to gain operational efficiencies through automated workflow. The activities include consolidating fault management information, process, enrich, and correlate that info against business objectives, instigate workflow automation against identified problem areas as well as for testing and provisioning activities. In that sense ALP 2.0 becomes a Product.

The ALP 2.0 solution provides a layer of functionality between the network element/manager and the business objectives of the user. This functionality allows the user to specify automated workflow which in turn directs the solution to troubleshoot, auto-correct, and provision the services within the network. The end result of this level of automation is to lower operations cost, lower mean-time-to-repair, and return service from outages more quickly than manual workflow driven model.

The ALP 2.0 solution works “in the background”. The solution consumes inputs from faults and enhances those faults with enrichment data from the storage systems. These enriched faults are processed against various configuration rules and correlation techniques which intern yield actions as defined within a workflow. It is not meant to automate all workflows, only those that are repeatable and candidates for automation. At the point the system is unable to progress the workflow, it will interface with a human (e.g. open a trouble ticket) for guidance and direction. Limiting the amount of human interaction helps to achieve the targeted cost efficiency goals.

ALP 2.0 functionality will be derived from the existing ALP 1.0 functionality as deployed within Telecli, which means 100% of functionalities should be migrated. This set of requirements has some reuse capability within the other business units throughout the world and as such will lower cost to implement. However, it is required large amount of new development to support the differing technologies at each global business unit.

In addition, the ALP 2.0 solution allows customization of rules and interfaces to support the various business operational models of the various global business units.

The high level characteristics of the solution are the following:

- Fault alarm collection, consolidation, normalization
- Enrichment capabilities of alarms
- Discard Rules processing
- Correlation Rules processing
- Action/Task administration including prioritization and limiting
- Provisioning
- High volume processing
- Integration platform with a large number of endpoints (NEs, applications, systems)
- Extendable integration for legacy and additional endpoints
- Flexible workflow system
- Standardized platform to capture intellectual property in reusable fashion

The new system will automate workflow in order to achieve the goal of reducing costs for the operational business for the operator.

5.4. Project analysis

In this section project analysis will be explained, including important things such as the system context, the actors that will interact with the system and those interfaces trough which to access the system. Finally Requirements will be listed and described.

5.4.1. System Context

The system context helps to represent those actors external to the system that interact with it. Bellow we can see how different actors interact with ALP 2.0 [5]:

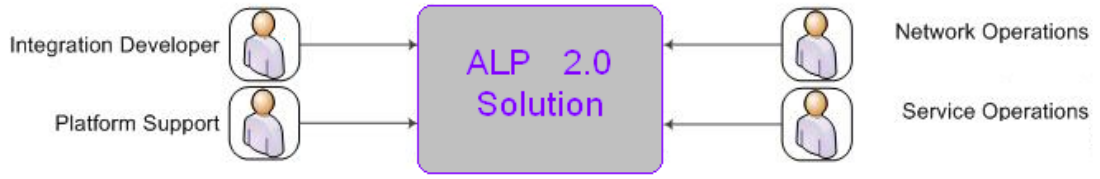

Figure 16 – ALP Solution 1

But we should get more into details, here I provide a context diagram [5] defining the proposed solution boundary and key external interfaces to users, systems, and networks.

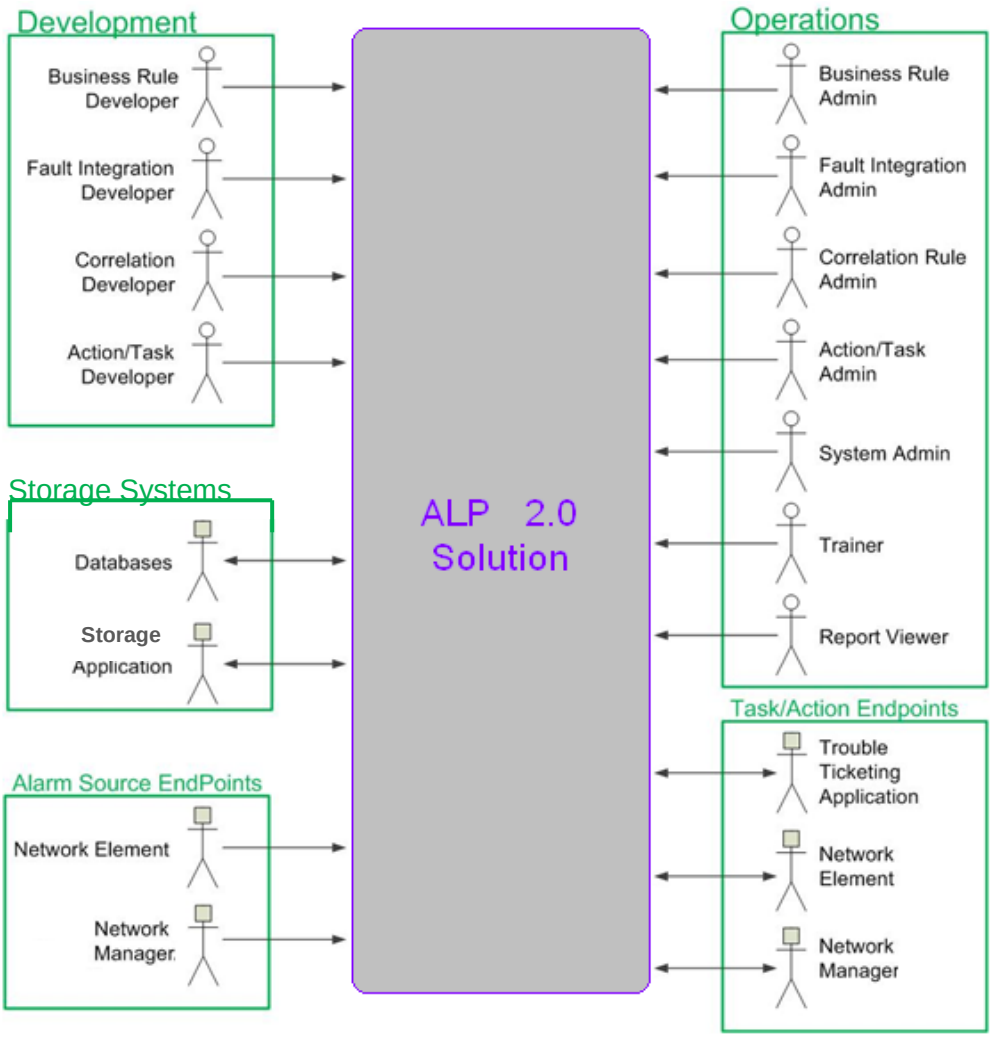

Figure 17 – ALP Solution 2

This figure (Figure 17) is illustrated according the Unified Modeling Language (UML) model. The symbols represent the actors. An actor is an idealization of an external person, process, or thing interacting with the system. An actor characterizes the interactions that outside users may have with the system. Actors which in fact are computers of automated devices are indicated as square head symbols. This is to distinguish a human actor from a non-human actor. Any human invocations which are behind the computer or automated devices (square heads) are not depicted.

5.4.1.1. System interfaces and stakeholders

Here I provide a description of the system interfaces and actors that interact with the system [5], their responsibility is detailed, as well the way they interact with ALP 2.0 and this interaction direction.

Actor	Interface Description	DIR	Who
Development			
Business Rule Developer	Responsible for creating the framework within with to specify the business rules within the system.	T	Alcatel-Lucent
Fault Integration Developer	Create software components that accept fault feeds from Alarm Source Endpoints. This activity will be first performed by Alcatel-Lucent however the customer is able to add additional fault integrations as necessary.	T	Alcatel-Lucent and CUST
Storage Integration Developer	Create integrations with sources of stored data. This activity will be first performed by Alcatel-Lucent however the customer is able to add additional storage integrations as necessary.	T	Alcatel-Lucent and CUST
Correlation Developer	Provide mechanisms for correlation methodologies with which events can be associated within the system	T	Alcatel-Lucent
Action/Task Developer	Develop workflows and communication modules to external systems/devices/ applications to affect change or otherwise take an action on a Task/Action Endpoint. This activity will be first performed by Alcatel-Lucent however the customer is able to add additional actions/tasks as necessary.	T	Alcatel-Lucent and CUST
Storage Systems			

Databases	The interface to a database of record which can provide additional info about alarms to enrich those alarms for use in fault processing.	T	Alcatel-Lucent and CUST
Storage Application	The interface to a storage application which provides additional info about the alarms to enrich those alarms for use in fault processing.	T	Alcatel-Lucent and CUST
Alarm Source Endpoints			
Network Element	Interface to the network elements that will provide fault information to the solution directly as they do not funnel through a management application. This activity will be first performed by Alcatel-Lucent however the customer is able to add additional alarm source endpoints as necessary.	T	Alcatel-Lucent and CUST
Network Manager	Interface to the Network Manager that will provide fault information to the solution for the devices it manages. This activity will be first performed by Alcatel-Lucent however the customer is able to add additional alarm source endpoints as necessary.	T	Alcatel-Lucent and CUST
Operations			
Business Rule Admin	Responsible for creating and administering the business rules within the framework to appropriately process the alarms. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional business rules as necessary.	T	Alcatel-Lucent and CUST

Fault Integration Admin	Configure the rules associated with the faults as they are added to the system. These rules specify the logical mappings for the information to the data model. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional fault integration rules as necessary.	T	Alcatel-Lucent and CUST
Storage Integration Admin	Specifies the relationships between the faults and their respective stored info. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional storage mapping rules as necessary.	T	Alcatel-Lucent and CUST
Correlation Admin	Configures the rules regarding the nature of the correlation of events. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional correlation rules as necessary.	T	Alcatel-Lucent and CUST
Action/Task Admin	Creates rules to associate fault correlations with their associated action/task. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional correlations to actions/tasks as necessary.	T	Alcatel-Lucent and CUST
System Admin	Provides the hardware infrastructure on which the system will be deployed as well as the Operating System and prerequisite software needed.	T	CUST
Trainer	Instruction as to the appropriate tasks and function of the system. Initial training will be performed by Alcatel-Lucent and the customer will perform additional training as needed thereafter.	T	Alcatel-Lucent and CUST

Report Viewer	Monitor the functioning of the system via reports	T	Alcatel-Lucent and CUST
Task/Action Endpoints			
Trouble Ticketing Application	Interface to the trouble ticketing application into which trouble tickets must be created/updated. This activity will be first performed by Alcatel-Lucent however the customer is able to add/modify these integrations as necessary.	B	Alcatel-Lucent and CUST
Network Element	Interface to the network element that is not managed by a Network Manager and needs an action taken whether corrective, investigational, or otherwise. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional integrations to actions/tasks as necessary.	B	Alcatel-Lucent and CUST
Network Manager	Interface to the Network Manager that is brokering the management of an end device which needs an action taken whether corrective, investigational, or otherwise. This activity will be first performed by Alcatel-Lucent however the customer is able to add/update/delete additional integrations to actions/tasks as necessary.	B	Alcatel-Lucent and CUST

The “DIR” (direction) column indicates the invocation direction of the actor. “T” means towards the system, “F” means from the system, and “B” is in both directions.

5.4.2. Requirements

Requirements are essential to know the reason of the project. The reason of a project is an aim, stated by the client. This aim the client establishes is divided into small objectives that are called requirements.

We should say that ALP 2.0 is such a huge project that there exist a great number of requirements. For this reason we have chosen to divide these into different categories of requirements. Another decision made to simplify the reading and understanding of the project is to reduce the number of requirements, mentioning and describing just the essential and most important ones of each category.

Bellow we can see the requirements grouped by categories [8]. After these, we will find those requirements that have to do with my work inside the project, with the portion of project with which I work, the one in charge of agents and alarm management:

5.4.2.1. Security Requirements:

5.4.2.1.1. Security Requirements

SEC-01	All servers which support Antivirus must be certified with McAfee AV and the servers must be updated regularly with these AV updates
SEC-02	ALP will be fully compliant to security standards and policies internal to customer.
SEC-03	It will provide an appropriate list of current best industry standards deemed relevant to customer.
SEC-04	It will be provided some mechanisms to perform an adequate identity management and a traceability of each of the operations of the common component (switches, routers, load balancers, firewalls) and of each of the individual services (servers and applications).
SEC-05	It will be provided proper mechanisms to collect the log of the architecture's common component and of each of the individual services (servers and applications. In order to comply with the current and local legislation (Data Privacy, Telecommunications Data Retention).
SEC-06	It will be provided the necessary mechanisms to synchronize, with precision, with NTP and the integration of the architecture's common component (switches, routers, load balancers, firewalls) and of each of the individual services (servers and applications).
SEC-07	It will be provided the necessary mechanisms to perform an adequate monitoring of the traffic produced on the common architecture.
SEC-08	It will ensure detection of passive probes for security supervision. In concrete the system would count with an IDS probe in the Service Center capable of monitoring all the traffic from the services and thus detect all the anomalies derived from illegitimate traffic.

5.4.2.1.2. Identification and Authentication

SEC-09	Users will have only access to the data they need. Therefore, systems must allow the creation of access profiles that limit user access to information for which they are authorized (configuration data, performance, etc.)
SEC-10	ALP will provide a mechanism to filter and control the source IP addresses that can access its components. Filtering methods: - ACL - Solution IP controls (including host firewalls or Host IPS)
SEC-11	Each user will have a unique ID to recognize and demonstrate, certainly, any attempt to access or usage of computing resources from ALP.
SEC-12	ALP will require authentication for management access in both operating system and the applications that are essential for its operation. Authentication will be required in access through physical ports and through remote user access to ALP.
SEC-13	It will be able to integrate with a Centralized Authentication System (for example systems based on LDAP, RADIUS or TACACS+) in both operating system and the applications that are essential for its operation for authentication, authorization and accounting of users and for password management in order to identify in a unequivocal way the identity of person performing the access.
SEC-14	ALP will support authentication of users using Directory Server (LDAP protocol). Using one of these alternatives: a) Delegating authentication to the Directory Server (LDAP protocol): The system must be able to perform (and interpret) the bind operation. In this option, the system must be able to connect to Directory Server via SSL. b) Using the Directory Server as a key-store device: The system must be able to perform a query operation to retrieve the password and encryption support mechanism used by the centralized authentication as the encryption algorithm for passwords.
SEC-15	It will support the configuration of, at least, two different servers to provide redundancy in the authentication process.
SEC-16	It will support the configuration of, at least, an alternative authentication method (for example local authentication) in case of centralized authentication method unavailability.
SEC-17	When the centralized authentication method is not available, ALP will allow access “local emergency user” is configured as the last resort to allow access to the system in situations where the centralized authentication method is not available; the element must be configured to not allow access using the “local” user whenever the centralized server is active and available
SEC-18	It will be able to remove the default users in the system.
SEC-19	It will enable changing the password of all users in the system
SEC-20	It will support Radius configuration with minimum length of, at least, 8 alphanumeric characters, and encrypted storage.
SEC-21	It will be able to create and work with user IDs of, at least, 8 alphanumeric characters.
SEC-22	It will be able to disable all user IDs that have not been used for a certain period of time. This period of inactivity will be configurable with a typical value of 120 days, when the system is not configured to use centralized authentication.
SEC-23	Network Access to ALP must not display information (banner) regarding the server, such as the operating system, applications or version used, etc.
SEC-24	The passwords will not be visible on the screen when entered for the authentication process, for all types of permitted access

SEC-25	If authentication fails, the system will not disclose detailed information of the rejection cause. The system will only facilitate a generic error message
SEC-26	It will support that user identifiers will be automatically locked out after a predetermined number of consecutive failed authentication attempts (typical configured value 5) within a preset time interval (typical configured value 60 minutes). Similarly, ALP will support access account automatic reactivation after a predetermined time period (typical configured value 30 minutes), when ALP is not configured to use centralized authentication.
SEC-27	It will support the configuration of a Warning message after a satisfactory authentication process, to any kind of allowed access to ALP. The message content will be configurable. If this is not possible, it must be possible to configure a message to be presented in the pre-authentication process
SEC-28	ALP will be configured in order to display information concerning the date and time of last successful access, as well as the number of failed authentications since that date.
SEC-29	ALP will display the address of the equipment from which user accessed correctly the last time.
SEC-30	ALP will support to be configured to force a user to change the password on the next user access.
SEC-31	When ALP is not configured to use centralized authentication, ALP will support a configuration where password changes will be mandatory for any passwords that have not been changed during a configurable period of time. A typical value is 90 days.
SEC-32	The old password will be requested before continuing with the password change mechanism.
SEC-33	Confirmation of the new password will be requested before proceeding with the change.
SEC-34	When ALP is not configured to use centralized authentication, reusing at least the last 10 passwords will not be permitted.
SEC-35	ALP will be able to be configured to require 8 characters minimum length passwords.
SEC-36	ALP will be able to configure restrictions on the definition of passwords (for example, contain at least one capital letter, one symbol or number).
SEC-37	When password changes happens, ALP must check that new password will not be able to be guessed using dictionary-based techniques or rules, and therefore they cannot use words related to the user (address, date of birth, ID card, etc).
SEC-38	Passwords must be stored encrypted or using hash functions with restricted access.

5.4.2.1.3. Access Control

SEC-39	ALP will be able to integrate with a Centralized Authentication System so that allocation of privilege level will be done according to the information received from the authorization server, whenever the authorization process is successfully completed.
SEC-40	ALP will allow implementing access profiles so that level privileges will be applied for each user. This way it will be possible to strictly control operator actions in the equipment.

SEC-41	It must provide at least, a minimum two different access roles based on whether they are supervisors, without the ability to change the settings, or administrators, who area allowed to change settings and upgrade software.
SEC-42	Information access privileges and resource permissions must not be granted to individual users but profiles or roles.
SEC-43	It will provide a simple and intuitive way to see what asses a user has, when ALP is not configured to use centralized authentication.
SEC-44	Each user/component will be configured to only present authorized commands.
SEC-45	Screensaver setting support is recommended in the system console or Graphics User Interfaces. Screensaver will delete the information from the screen and block the terminal with a password after a configurable period of inactivity.
SEC-46	Screensaver setting support will be provided in the system console or Graphics User Interfaces. Screensaver will delete the information from the screen and block the terminal with a password after a configurable period of inactivity.
SEC-47	ALP must set timeouts for administration connections in order to avoid open sessions. Timeout value must be configurable. The typical value in production is 15 minutes.
SEC-48	ALP will include the support of Access Control List (ACL) or filters to limit administration and other protocols access only from certain source IP addresses ranges. It must be able to configure multiple disjoint ranges specified by IP network and mask.
SEC-49	It must be able to support the configuration of physical ports, disabling those which are not used. Unused physical ports in production deployed system must be explicitly disabled.
SEC-50	Each application or process, that requires access to or from a specific port number or IP address, will include the detail in the administration and configuration documents.
SEC-51	It will be a maximum limit of remote open sessions for management access.
SEC-52	It will be a dedicated management access (last vty), only accessible from a specific IP address range, to keep one free vty port for emergency access.
SEC-53	The platform will close all not required ports and will prevent it of any “back door” that permits a bypass of customer network and his security infrastructure.
SEC-54	ALP will be compatible with the corporate Privileged Users Access Control tool (for privileged users accessing to servers), Computer Associates Access Control (CA Access Control).

5.4.2.1.4. Network Security and Monitoring Logs

SEC-55	The generation of security event logs of equipments will be enabled, so that it will be possible to know actions taken on the equipment, and the accesses made to it, to allow further audit work and forensic examination.
SEC-56	Unsuccessful authentication attempts will be recorded.
SEC-57	The beginning and end user connections will be recorded.
SEC-58	The system will record all actions of administrators and configurators (usually users with maximum privileges).
SEC-59	The equipment will be configured to generate access logs to the console port.

SEC-60	The equipment will be configured to generate logs of denied traffic in IP traffic filters or ACLs.
SEC-61	ALP will support NTP (Network Time Protocol).
SEC-62	ALP will support NTPv4.
SEC-63	ALP will automatically adapt its local time to daylight saving time changes (summer - winter).
SEC-64	ALP will be able to configure access lists or equivalent security mechanism so that it can restrict the reception of the time reference only from authorized source IP addresses.
SEC-65	At least, two NTP servers will be supported to ensure availability and accuracy of the information from the system clock.
SEC-66	The network elements will be configured so as it not permitted routing IP traffic between different interfaces.
SEC-67	It will be able to prevent the passage of IP packets with potentially dangerous IP options or source routing redirects.
SEC-68	ALP will be able to disable sending ICMP unreachable message when a packet is denied by an access list.
SEC-69	The TCP systems with Internet-accessible services will support a mechanism of protection against SYN flood attacks.
SEC-70	The system communications will be able to be encrypted if these happens from remote user access to internal corporate network (via telephone lines, wireless, Internet ...).
SEC-71	If ALP supports WiFi interfaces, it will support encryption of wireless communications through WPA and WPA2.
SEC-72	The equipment will include encrypted and authenticated management protocols such as SSH, SFTP, SCP, SNMPv3, HTTPS, instead of protocols which transmit information in clear and without integrity checking.
SEC-73	SSH protocol requirements: a) SSH is used to encrypted login access as an obliged replacement for telnet. SSHv2 server support is used. b) Server functionality support is used. c) ALP must support user/password based authentication. d) ALP must support public key authentication (RSA or DSA). e) AES-128 and 3DES support is used
SEC-74	SCP protocol requirements: a) The system must implement SCP protocol with SSH support for data encryption in file transfer operations. b) It will work in client mode and server mode

5.4.2.1.5. Software Control

SEC-75	It will be able to disable not needed services.
SEC-76	ALP will be capable of detecting a configuration inconsistency, defend against this effect and generate an alarm. This verification must be completed before the configuration is active.
SEC-77	ALP will be capable of detecting when it has insufficient memory to load new configurations or software, and prior notice the occurrence of an event, disabling the version and keeping the previous configuration.
SEC-78	It will have mechanisms to detect and prevent the installation or execution of malicious code (viruses, Trojans, worms...).

5.4.2.1.6. IPv6

SEC-79	ALP will have IPv6 filtering routing capabilities.
SEC-80	ALP will support ACLs for IPv6 as for IPv4.
SEC-81	Management protocols like SNMP, NTP, SSH etc. will be supported with IPv6.
SEC-82	ALP will allow disable running services in IPv6.

5.4.2.2. Interface Requirements

WEB-01	The system will include a browser-based GUI
WEB -02	The GUI will be intuitive and user friendly
WEB -03	The system will offer a dynamic and real-time data visualization
WEB -04	The pages displaying an output table will contain a reload button that will allow reloading the screen immediately without waiting the remaining time until the next recharge.
WEB -05	The pages displaying an output table will allow the user to select if user interface refresh is required, and in affirmative case, the user will be able to select the refresh period in seconds. Following refresh periods will be provided: None/10 sec/20 sec/30 sec/1 min/5 min
WEB -06	All system screens will display the ALP logo on the top left corner.
WEB -07	All system screens will include on-line help
WEB -08	All system screens will allow to send a mail to the system responsible
WEB -09	All system screens will provide access to phone numbers to provide immediate attention to the user
WEB -10	The return to the previous screen will be done with the back button as in a windows explorer
WEB -11	The system will provide access to the administration activities
WEB -12	The system will provide access to the ALP documentation
WEB -13	The system will provide restricted access to the documentation according to the user profile
WEB -14	The portal shall be multi-language in order to support Spanish, English, German, Czech or Portuguese languages
WEB -15	All system screens will allow the user to configure the default language of the user interface portal and development portal
WEB -16	The system will allow the user to monitor the system Alarms and Notifications.
WEB -17	The system access screen will contain following fields that should be filled by the user: User, Password and Remind password option
WEB -18	The system access screen will provide a link to new user creation
WEB -19	The system access screen will provide a link to I forgot my password
WEB -20	The new user creation link will display a template containing following fields that should be filled by the user: - User type (Company to which the user belongs to. It will be a drop down menu with possible options) - User (following characters will be allowed: a-z, A-Z, 0-9, !@#$%^&*_+-={}|./?'~`) - Name - Surname - Email - Password - Password confirmation
WEB -21	After new user creation request, the user will receive an automatic Email (without human intervention) containing a link that should be accessed by the user in order to finish the creation process.
WEB -22	The I forgot my password link will display a template containing following fields to be filled by the user: - User type (Company to which the user belongs to. It will be a drop down menu with possible options) - User
WEB -23	In case of I forgot my password, the new password will be sent automatically (without manual intervention) to the user via e-mail
WEB -24	The system will force the user to change the password in the first login after receiving the password via Email (in case of "I forgot my password" and in case of "massive users creation")

WEB -25	Once a user has been created, the user will have basic access rights
WEB -26	The user will be able to visualize and update his personal data
WEB -27	The user will be able to change his password
WEB -28	The user will be able to visualize his access rights
WEB -29	The user will be able to request access rights update
WEB -30	After access right update request, the administrator will send an e-mail to the user indicating if the request has been accepted or rejected,
WEB -31	The user will have customized views according to the user profile
WEB -32	The system will allow to display the information filtered by country
WEB -33	The system will include at least one user profile with rights to see multi-country information
WEB -34	The system will allow the user profile with rights to see information of more that one country, the capability to change in hot the country to display the information
WEB -35	None information of a country will be showed to a not authorized user profile
WEB -36	The administrator will be able to delete users
WEB -37	The administrator will be able to execute the launch Disaster Recovery steps from the user interface
WEB -38	The administrator will be able to execute the launch Restore from the user interface
WEB -39	The administrator will be able to execute the launch backup from the user interface
WEB -40	The administrator will be able to accept/reject update profile requests
WEB -41	The administrator will be able to create users massively. The system will send an Email automatically (without manual intervention) to each user containing the user and password.
WEB -42	The administrator will be able to assign/un-assign users to groups massively
WEB -43	The administrator will have access to a window displaying all pending access requests
WEB -44	The system will allow the user to monitor all networks from which ALP receives events.
WEB -45	The user interface will display a control map per Technological Area/Equipment Family containing the following information for every element manager: - Date of the last event received - Total number of events received - Number of events pending - Number of events filtered - Number of events inhibited - Number of events treated - Number of events no sent - Last event treated
WEB -46	The user interface will display a control map per Technological Area/Equipment Family containing following information: Number of jobs queued, pending of execution, executing, to be repeated, inhibited, blocked, finished and the execution result
WEB -47	The user interface will display a control map per Technological Area/Equipment Family containing following information: Number of tickets created successfully, Number of tickets modified successfully and Number of tickets without success (creation or modification finished without success)
WEB -48	The user interface will provide filters that allow the user to configure the events to be displayed in a Equipment Family: - Events received according the following input data: id, start date, end date, element manager name, network element name, pattern to apply in the event text, events to apply the filter (received, retained, filtered, inhibited, treated or generated in ALP) and the event class.
WEB -49	The user interface will provide filters that allow the user to configure the jobs to be displayed in a Equipment Family: - Jobs executed according the following input data: id, start date, end date, status, job type, error code, completion code

5.4.2.3. Automation Requirements

In this section I will expose requirements that have to do with my job in the company and the elements with which I work. Even though I work with certain technologies, the requirements that have to do with agents, alarms, commands and trouble tickets treatment are the same for all of the technologies. In the following sections this requirements will be reviewed in detail.

5.4.2.3.1. Agent requirements

AUT-01	Agents will be all collected and stored in the same format
AUT-02	Agents will all contain a description of what is their job
AUT-03	Agents will be classified by technology
AUT-04	Agents will contain an attached list of those alarms that trigger them and their IDs
AUT-05	Agents will be triggered by at least one alarm
AUT-06	Agents will mention the kind of trouble tickets they generate (in the case they do)
AUT-07	Agents collection will be carried out following the technologies relevance order

5.4.2.3.2. Alarm requirements

AUT-08	Alarms will be all collected and stored in the same format
	Alarms file will all contain the following fields:
	ID
	Group
	Name
	Description
	Criticality
	Parameters
AUT-09	Validity Hours
	Treat (yes/no)
	Agent
	Persistence
	Shortest Period
	Largest Period
	Average Period
	Comments

	Massive Server
AUT-10	Alarms must be identified as proactive or reactive alarms
AUT-11	Alarms file will contain information about those countries that will include them
AUT-12	Alarms will be classified by technology
AUT-13	Alarms will trigger at least one agent
AUT-14	Alarms collection will be carried out following the technologies relevance order

5.4.2.3.3. Command requirements

AUT-15	Commands may be introduced as a response to an alarm starting up a reactive process
AUT-16	Commands may be introduced to start up a proactive process
AUT-17	Commands will be all collected and stored in the same format in the command list
AUT-18	In the command list, commands will all contain a reason for executing them, the consequences that might require their use
AUT-19	In the command list, commands lists will all contain a description with what will happen when executing the commands contained in the list
AUT-20	Commands will be classified by technology
AUT-21	Commands will at least be useful for one technology but may be used in more than one
AUT-22	Commands may contain parameters
AUT-23	In the command list, format of the parameters will be specified
AUT-24	In the case commands rise alarms, alarms' ID will be the parameter
AUT-25	Commands collection will be carried out following the technologies relevance order
AUT-26	In the command list, routines of commands will contain a description of what they do
AUT-27	In the command list, dependent commands will mention which commands they depend on and those that should be introduced afterwards, with the objective of structuring an organized chain.

5.4.2.3.4. Trouble ticket requirements

AUT-28	Trouble tickets will be all collected and stored in the same format in the trouble tickets list
AUT-29	In the trouble tickets list, trouble tickets will all contain reason for launching them
AUT-30	In the trouble tickets list, the agents that may launch them will be specified
AUT-31	Commands will be classified by technology
AUT-32	Trouble tickets will contain a description of the problem
AUT-33	Trouble tickets will be launched every time there is a problem that needs to be solved
AUT-34	TT may contain parameters
AUT-35	In the TT list, format of the parameters will be specified
AUT-36	Trouble tickets collection will be carried out following the technologies relevance order
AUT-37	Trouble tickets must be closed by operator when the incidence is resolved
AUT-38	TT historical will be actualized whenever a trouble ticket arises and it is resolved

5.4.3. Use Cases

In this section, I will mention and describe the most important use cases of the ALP 2.0 project [4]. Fields such as the Primary Actor, the Scope, the Level and the Story will be detailed, although you will notice the level will just acquire two possible values; Summary and Personal. Summary use cases are the ones that go over the project's processes and functionalities, while Personal use cases will be shown at the very end, and are those that have to do with the jobs that I develop inside Alcatel-Lucent.

5.4.3.1. Operational Use Cases

ID: UC-01 **Title: Consume Alarms from Alarm Source Endpoint – Network Element**

Primary Actor:	Network Element
Scope:	A device type that will send alarms to the system and is not managed by a Network Manager or EMS
Level:	Summary
Story:	A device or network element proactively sends or otherwise is polled for alarms to be consumed by the system. These alarms must be partitioned from each other and inserted as unique entities within the system. Each alarm must be divided into key value pairs and assigned to a normalized data model ready for processing.

ID: UC-02 **Title: Consume Alarms from Alarm Source Endpoint – Network Manager/EMS**

Primary Actor:	Network Manager, EMS, or Umbrella Alarm Management System (UAMS)
Scope:	A device type that sends its alarms to an intermediate system a Network Manager/EMS which in turn provides the alarm stream to the system
Level:	Summary

Story:	A Network Manager/EMS proactively sends or otherwise is polled for alarms collected and are to be consumed by the system. These alarms must be partitioned from each other and inserted as unique entities within the system. Each alarm must be divided into key value pairs and assigned to a normalized data model ready for processing.

ID: UC-03 **Title: Enrich Alarm with Storage Information - Database**

Primary Actor:	Databases
Scope:	Manually maintained stored information within a standalone database
Level:	Summary
Story:	The system queries the database for information to enrich the alarms. This information is used to better process the alarm through the business rules. This database is not managed by a storage application but is manually maintained.

ID: UC-04 **Title: Enrich Alarm with Storage Information – Storage Application**

Primary Actor:	Storage Application
Scope:	An application tracking stored information
Level:	Summary
Story:	The system queries the storage application for information to enrich the alarms. This information is used to better process the alarm through the business rules.

ID: UC-05 **Title: Create Framework for Business Rule Management**

Primary Actor:	Business Rule Developer

Scope:	Core System functionality
Level:	Summary
Story:	The developer will create the mechanisms for business rules to be configured and applied to the alarms. This includes all GUIs and processes to facilitate capturing the business rule and processing it within the system.

ID: UC-06 **Title: Create Framework for Fault Integration**

Primary Actor:	Fault Integration Developer
Scope:	Core System functionality
Level:	Summary
Story:	The developer will create the mechanisms for accepting the fault alarm data into the system. This activity includes capturing the alarm, creating the means of delimiting that data into useful field/value pairs, and developing the GUIs and workflow processes to assign those pairs to a normalized data structure.

ID: UC-07 **Title: Create Framework for Storage Integration**

Primary Actor:	Storage Integration Developer
Scope:	Core System Functionality
Level:	Summary
Story:	The developer will create the mechanism which enables the user to map the appropriate fault alarms with their respective stored information. This framework includes GUIs and workflows to manifest the system data and provide a choice to the user for establishing these relationships. In addition, all storage integrations must be logged to support the reporting feature of the system.

ID: UC-08 **Title: Create Framework for Correlation**

Primary Actor:	Correlation Developer
Scope:	Core System Functionality
Level:	Summary
Story:	The developer will create the GUIs and subsequent workflow processing to facility correlation schemes. The system user will pick from the available correlation types and configure the faults to be correlated using this framework. In addition, all correlations must be logged to support the reporting feature of the system.

ID: UC-09 **Title: Develop the Framework for managing Action/Task**

Primary Actor:	Action/Task Developer
Scope:	All "Action/Task Endpoints" including trouble ticketing applications, network elements, and network managers/EMS which will require integration for executing tasks
Level:	Summary
Story:	The developer will create the GUIs and workflow processes to manage the mapping of fault correlation to Actions/Task execution. This includes the functionalities of filtering actions, prioritizing actions, limiting actions based on number of processes per endpoint and per action type, and limiting based on a schedule. In addition, all actions must be logged to support the reporting feature of the system.

ID: UC-10 **Title: Action/Task Endpoint Integration to Task/Action Endpoints**

Primary Actor:	Trouble Ticketing app, Network Element, Network Manager/EMS
Scope:	All "Action/Task Endpoints" including trouble ticketing applications, network elements, and network managers/EMS which will require integration for executing tasks
Level:	Summary
Story:	An interface to the endpoint and all the actions that will be executed on that interface. These actions will be assigned by the user as a result of some alarm processing to create/update trouble tickets, perform checks of system availability/functionality or to perform corrective actions. These actions can be performed on a trouble ticketing application, directly to a network element, or to a Network Manager/EMS that is responsible for managing the end device.

ID: UC-11 **Title: Configure Business Rules for Fault Processing**

Primary Actor:	Business Rule Admin
Scope:	Fault Alarm Processing
Level:	Summary
Story:	The actor will use the GUI tools to associate the fault alarms with their business rule workflows including filtering and classification of alarms.

ID: UC-12 **Title: Configure the Fault Alarm Normalization Rules**

Primary Actor:	Fault Integration Admin
Scope:	Fault Alarm Integration
Level:	Summary
Story:	The admin will use the tools provided to configure the relationships between the raw alarms and the system data model so as to normalize the alarms across all alarm sources.

ID: UC-13 **Title: Configure the Enrichment Process for Storage Information**

Primary Actor:	Storage Integration Admin
Scope:	Fault Alarm Enrichment
Level:	Summary
Story:	The admin will use the tools provided to configure the appropriate mappings of alarm info to the fault. This includes the relationship of the data to the appropriate column in the data model.

ID: UC-14 **Title: Configure the Correlation Rule to Fault Mapping**

Primary Actor:	Correlation Rule Admin
Scope:	Fault Alarm Processing and Correlation
Level:	Summary
Story:	The admin will use the correlation framework to specify which correlation methodologies should apply to the faults. The result of this configuration will direct the system to find the scenarios which should have task/actions run against it.

ID: UC-15 **Title: Configure the Fault to Action/Task Mapping**

Primary Actor:	Admin/Task Admin
Scope:	Task/Action Execution
Level:	Summary
Story:	The admin will map the defined correlations to their respective tasks and actions. This will direct the system which tasks/actions to perform once it finds the defined scenario.

5.4.3.2. System Admin Use Cases

ID: UC-16 **Title: Administer software and hardware**

Primary Actor:	System Admin
Scope:	System processes and hardware support
Level:	Summary
Story:	The admin will ensure the system is properly installed and all processes are running for proper operation.

ID: UC-17 **Title: Administer User Authorization Profiles**

Primary Actor:	System Admin
Scope:	Solution user administration and authorization
Level:	Summary
Story:	The admin will administer user access privileges and setup the user with access to tool features. Some examples where this might apply are the following: • Access to Business Rule Configuration

	• Access to Fault Alarm Normalization Rule Configuration • Access to Enrichment Rule Configuration • Access to Correlation Rule Configuration • Access to Fault to Action/Task Mapping Configuration • Access to Operational Reports • Specify the data the user is able to manage. This might be used in the case where multiple operation centers are sharing a single instance of the solution due to business restraints. Data from multiple networks collocated however user access must be controlled to separate the view of the data.

ID: UC-18 **Title: Transfer Knowledge to Administration of the System**

Primary Actor:	Trainer
Scope:	All "admin" level tasks only
Level:	Summary
Story:	The trainer will conduct knowledge transfer sessions for the administrators regarding proper configuration and administration of the solution. This includes business rule administration, fault integration administration, storage integration administration, correlation rule administration, and action/task administration. The concepts learned enable the administrators to create the appropriate settings for the system to accurately act upon the fault scenarios.

ID: UC-19 **Title: Review Reports for Historical Operational Performance**

Primary Actor:	Report Viewer
Scope:	Storage Enrichments, Correlations workflows, and task/action execution

Level:	Summary
Story:	The reports outline the operational characteristics the system has on the network including how faults are enriched (how many, from where most often), which correlation workflows are run (how many, most often fired), and the number of tasks/actions executed.

ID: UC-20 **Title: Failure of Primary System to Backup system**

Primary Actor:	System Admin
Scope:	All interfaces, internal databases, internal processing engines
Level:	Summary
Story:	Upon failure of a primary component, the system will recover processing of the events from a backup/secondary component without intervention of a system administrator. Disaster Recovery is not a requirement.

ID: UC-21 **Title: Troubleshoot Functionality Errors**

Primary Actor:	System Admin
Scope:	All interfaces, internal databases, internal processing engines
Level:	Summary
Story:	The system administrator and operational staff will investigate workflow failures using the GUIs and log file mechanisms implemented within the system. Possible failures that could produce workflow failures are the following: • Alarm Source Endpoint disconnect • Storage System disconnect • Task/Action Endpoint disconnect • Business Rule Misconfiguration • Fault Integration Misconfiguration

	• Storage Integration Misconfiguration • Correlation Rule Misconfiguration • Action/Task Misconfiguration

ID: UC-22 **Title: Capacity Management**

Primary Actor:	System Admin
Scope:	All interfaces, internal databases, internal processing engines
Level:	Summary
Story:	The system will capture metrics to provide a systematic load of the system. This information can be analyzed to determine when additional processing capacity is necessary to keep up with the demand.

5.4.3.3. Maintenance & Support Use Cases

ID: UC-23 **Title: Alarm Source Endpoint Interface Upgrade**

Primary Actor:	Alarm Source Endpoint
Scope:	Interface to Network Element or Network Manager/EMS
Level:	Summary
Story:	Upon an interface change of the external Alarm Source which breaks the existing interface agreement, the interface between the system and this Alarm Source must be updated

ID: UC-24 **Title: Storage System Interface Upgrade**

Primary Actor:	Storage System
Scope:	Databases and Storage Application
Level:	Summary
Story:	Upon an interface change of the external Storage system breaks the existing interface agreement, the interface between the system and this Storage source must be updated

ID: UC-25 **Title: Task/Admin Endpoint Interface Upgrade**

Primary Actor:	Task/Admin Endpoint
Scope:	Interface to Trouble Ticketing Application, Network Element, or Network Manager/EMS
Level:	Summary
Story:	Upon an interface change of the external Task/Admin Endpoint which breaks the existing interface agreement, the interface between the system and this Task/Admin Endpoint must be updated

ID: UC-26 **Title: Configurable Components must be able to be Deactivated for Troubleshooting**

Primary Actor:	Core System Functionality
Scope:	Business Rules, Fault Integration, Storage Integration, Correlation Rules, Action/Tasks
Level:	Summary
Story:	In case of failures, each configurable component must have the ability to turn of the offending object such that the rest of the system can continue to function while it is fixed. An example of this is a new Business rule is added however a typo was made which created a conflict with another already configured

	business rule. The new business rule must be deactivated while it is fixed so that the previous rule can continue running.

5.4.3.4. Automation Use Cases

These use cases are the ones that describe the section of the project on which I work and the labours that I carry out during my working period in Alcatel-Lucent. They are associated with the core of the automation processes that the project wants to implement.

ID: UC-p01 **Title: Identify command technology**

Primary Actor:	Integration Developer
Scope:	Command processing
Level:	Personal
Story:	The actor will use last version documentation to associate the command with the technology to which it belongs and to build up command prototype or pattern useful for other commands from the same nature and similar objective.

ID: UC-p02 **Title: Identify command attributes**

Primary Actor:	Integration Developer
Scope:	Command processing
Level:	Personal
Story:	The actor will identify attributes contained in commands by identifying the attribute format and carrying out a research of possible values through ALP 1.0 data and generated scripts contained in databases, command reports, alarm reports and trouble ticket scripts.

ID: UC-p03 **Title: Identify command triggering reasons**

Primary Actor:	Integration Developer
Scope:	Command processing
Level:	Personal
Story:	The actor will identify the reasons for a command to be executed, this includes the agent that triggers the command and the purpose for activating or sending it. This investigation will be carried out by examining the agent's code and correspondent alarm scripts.

ID: UC-p04 **Title: Generate command information file**

Primary Actor:	Integration Developer
Scope:	Command processing
Level:	Personal
Story:	The actor will generate a file collecting all command information, including the reasons for it to be triggered and the consequences of its activation as well as the attributes that it may contain and the agents that may make use of it. This information will be obtained from the labors performed on UC-p01, UC-p02 and UC-p03.

ID: UC-p05 **Title: Command classification and filtering**

Primary Actor:	Integration Developer
Scope:	Command processing
Level:	Personal
Story:	The actor will classify commands assigning them an execution priority depending on the importance of the purpose. Afterwards a filtering will be established depending on the command relevance and the status of the system.

ID: UC-p06 **Title: Identify alarm technology**

Primary Actor:	Integration Developer
Scope:	Alarm processing
Level:	Personal
Story:	The actor will use last version documentation to associate the alarm with the technology to which it belongs and to build up alarm pattern containing a list of those agents that may manage it.

ID: UC-p07 **Title: Identify alarm nature**

Primary Actor:	Integration Developer
Scope:	Alarm processing
Level:	Personal
Story:	The actor will process alarm scripts and code residing on the managers that trigger alarms in order to find out its nature; Proactive or Reactive alarm. Alarm's nature is of extreme importance in order for alarms to be prioritized.

ID: UC-p08 **Title: Identify alarm parameters**

Primary Actor:	Integration Developer
Scope:	Alarm processing
Level:	Personal
Story:	The actor will identify alarm parameters by identifying their format and carrying out a research of possible values through ALP 1.0 data and alarm forms the task manager received in previous version, contained in databases.

ID: UC-p09 **Identify alarm triggering reasons**

Primary Actor:	Integration Developer
Scope:	Alarm processing
Level:	Personal
Story:	The actor will identify the reasons for an arising alarm, this can be found out by reviewing the processes that failed and the parameters passed on to the correspondent agent. In the case of a Proactive alarm, the periods or persistence and mainly the attributes may lead to the purpose of the alarm.

ID: UC-p10 **Title: Generate alarm information file**

Primary Actor:	Integration Developer
Scope:	Alarm processing
Level:	Personal
Story:	The actor will generate a file containing all alarm details, including the fields contained in AUT-09 requirement. This information will be obtained from the labors performed on UC-p06, UC-p07, UC-p08 and UC-p09.

ID: UC-p11 **Title: Identify alarms triggering agents**

Primary Actor:	Integration Developer
Scope:	Agent processing
Level:	Personal
Story:	The actor will review alarm information files gathering information about agents that should be activated by the correspondent alarms arising. Each agent responds to a series of alarms in order to solve certain incidences, these alarms are now collected.

ID: UC-p12 **Title: Identify agent that generates trouble ticket**

Primary Actor:	Integration Developer
Scope:	Trouble Ticket processing
Level:	Personal
Story:	The actor will examine trouble ticket scripts collecting those agents that generated the trouble tickets. This information will be afterwards confirmed by reviewing the agent implementation and looking for the method of the correspondent ticket creation.

ID: UC-p13 **Title: Generate agent information file**

Primary Actor:	Integration Developer
Scope:	Agent processing
Level:	Personal
Story:	The actor will generate a file collecting all agent information, including the alarms that trigger it and the consequences of its activation, this is, the commands that it may execute over different technologies and the trouble tickets created in case it is necessary. This information will be obtained from the labors performed on UC-p03, UC-p11 and UC-p12.

ID: UC-p14 **Title: Generate trouble ticket information file**

Primary Actor:	Integration Developer
Scope:	Trouble Ticket processing
Level:	Personal
Story:	The actor will generate a file collecting all trouble ticket information, including the incidences that triggered the trouble ticket, the actions and decisions the operators and supervisors took due to the trouble ticket received and the Agent that generated the trouble ticket. This information will be obtained from those incidence forms stored in the database and from the labor performed on UC-p12.

5.5. Project Design

5.5.1. System Architecture

This section may be one of the most important ones in order to understand what it ALP about and how it works, it is the one in charge of allocating all the information we have analysed until now and giving it a shape.

The architecture used by the system, it is a three tier high availability architecture. Three tier because it is MDV architecture and high availability as it guaranties that the loss of information and unavailability of the system is minimum. It improves data integrity by performing regular backups and also it increases performance.

In the following schema it is shown the hardware and security architecture of the system [5]:

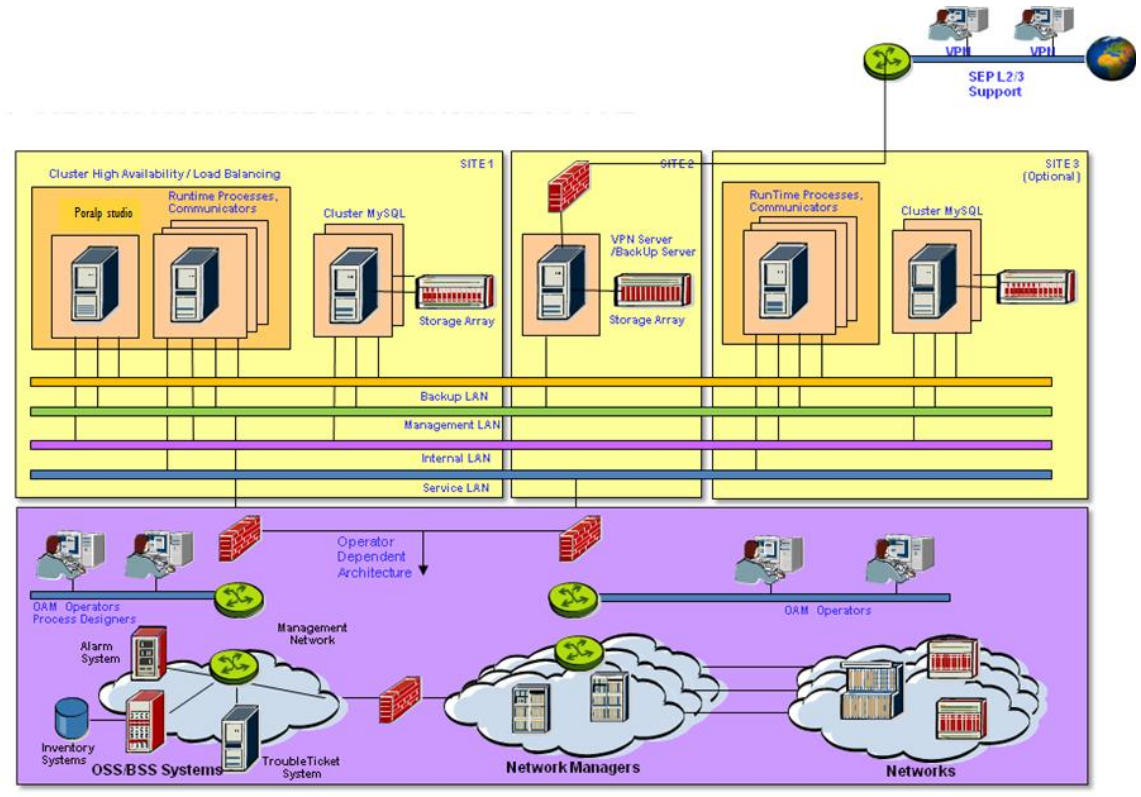

Figure 18 – HW Architecture

5.5.2. ALP Communications

After the architecture overview, it is time to take a look at internal processes and communications between services and interfaces. In the image bellow we can see every single communication between different items that build up ALP 2.0. We can distinguish ALP modules, PORALP platform and external applications and in which way they interact. We will deeply analyse these communications and interchanges in further sections.

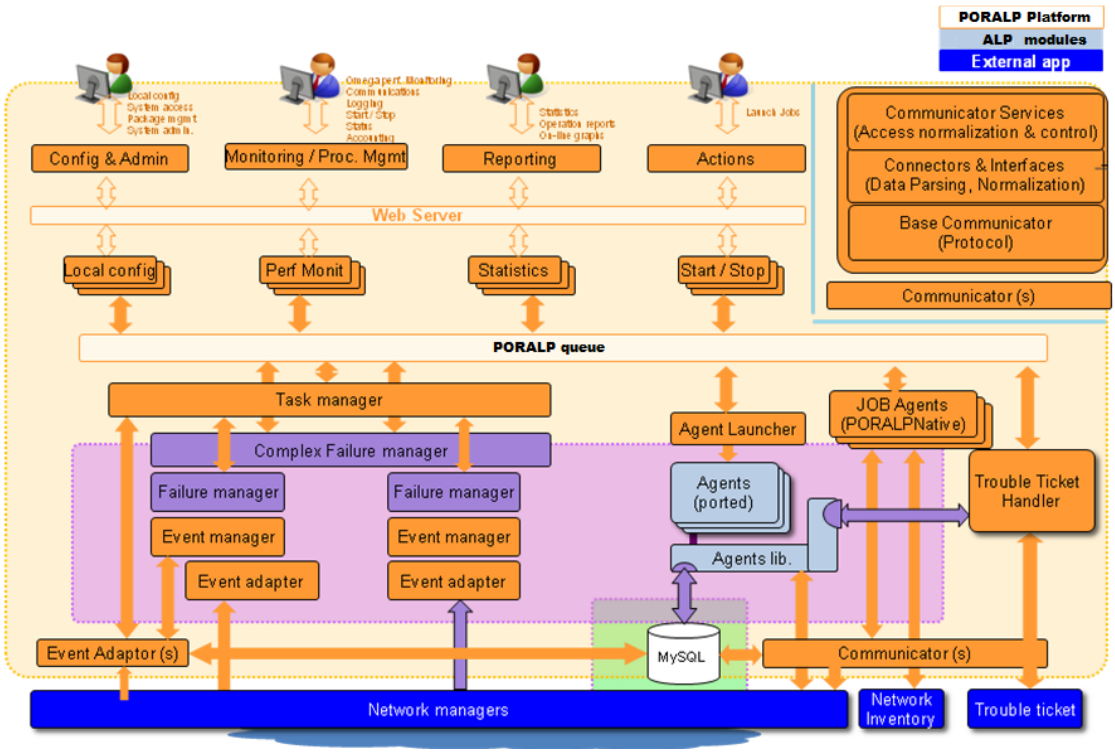

Figure 19 – ALP Communications

We can see in Figure 19 [5] how ALP runs on top of PORALP platform (ALP is the big purple square). ALP managers are usually activated by external applications, entirely composed by network managers. ALP managers will call ALP Agents to solve incidents and repair network problems. The main difference, apart from PORALP presence, between the last version of ALP and this new one we intend to perform is the managers' organization, being all contained in ALP 2.0 and organized in the way that Agents will be alarmed whenever an incidence happens and it is detected by the managers.

5.5.2.1. Automation Communications

It is time to explain in a very simple and intuitive way the section in which I operate in the company, those elements with which I work and the communications that take place between them. It will already sound familiar all this things that have to do with Agents, Alarms, Commands and Trouble Tickets, but the truth is that all has to do with this, as all the automation process is possible because of these elements. Now, we will take a look at the schema (Figure 20) and analyse every communication and element participating in this automation process.

I have to start saying that the incidence process that will be described is a reactive process and not a proactive one, in other words, is a process that takes place when an error or incidence arises, it does not start up to control or supervise, it is started up when a reactive alarm is activated by a network element. So an alarm is first activated by a network element, an alarm can be due to a small incidence or a huge one, for example, it can be activated due to a clock mismatch or due to a whole network failure. Never mind, whatever the alarm is about, it will be passed on to its correspondent network manager.

Network managers are very important inside the automation process, they help to organize alarms by networks and to prioritize them according to their relevance. These managers facilitate all information to the Event Manager, the priority, the technology, etc., so that the Event Manager does not lose any time organizing the alarms that keep arriving. The alarm will now be transferred to the Event Manager, the EM gathers all alarms, no matter the technology or importance, all alarms must reach this stage. The Event Manager will now transmit the alarms to ALP system, one by one, depending on the priority of the alarm combined with the priority of the incidence technology.

Alarms keep arriving to ALP stage, each alarm is normally assigned to its correspondent agent inside the ALP 2.0 system unless we are dealing with a routine or insignificant alarm. Some of the alarms are directly dismissed because of its relevance or just because it is stated that way, others that are usually repeated or are simple routines are attended by managers that carry on a stated process to attend a special and well known kind of alarm, and at last, others are assigned to an agent. This agent is not a random one, each kind of alarm, depending on the incidence and technology is identified with an agent that knows well what to do with it in order to solve the problem. The most common thing to happen is an alarm to be attended by its assigned agent, this agent executes a command directly over the network element with the objective of solving the incidence, and to finish, the incidence resolution process is stored

in the storage database so that future alarms similar to the one just solved are attended and dispatched faster and increasing performance.

It is possible to imagine that it is not always like this, not as easy as this. Very often, agents face an incidence not seen yet, without any information stored in the database and with no process to carry out previously established. This are those occasions in which the human hand has to hopelessly intervene in order to resolve the problem. When a not identified alarm reaches ALP 2.0 system or an executed command by an agent did not end successfully with the incidence, ALP 2.0, concretely the agent that is firstly assigned to solve the alarm request, opens a Trouble Ticket, this process, as its name points out, happens due to trouble when solving an incidence, and it is directly attended by the first human (after the developers obviously) the takes part in this process, these are the operators.

Operators are low technical people in charge of managing those Trouble Tickets that keep arriving when agents are not capable of repairing failures. They are supposed to have a background experience in attending these calls, so they will apply a simple procedure to solve the incidence. Problems do not end here and sometimes require of a more qualified dealer, this is the supervisor. Supervisors are qualified telecommunications people which labour is to solve all kind of problems. It is assumed that if they are not capable of solving it, no one will be qualified to do it. Supervisors sometimes have to make use of technicians that are transported to the place where the network incidence occurred to solve the problem.

Once the problem is fixed, the supervisor communicates it to the operator, realizing if possible a routine that helps to fix this kind of problem in the future. Operator will close the trouble ticket to indicate the network failure has been fixed, and ALP 2.0 agent in charge of the alarm that carried the incidence description enriches the database for future failures similar to the one just fixed.

It is a simple and productive refeeding process that enables the possibility of learning from experience and automating unknown processes.

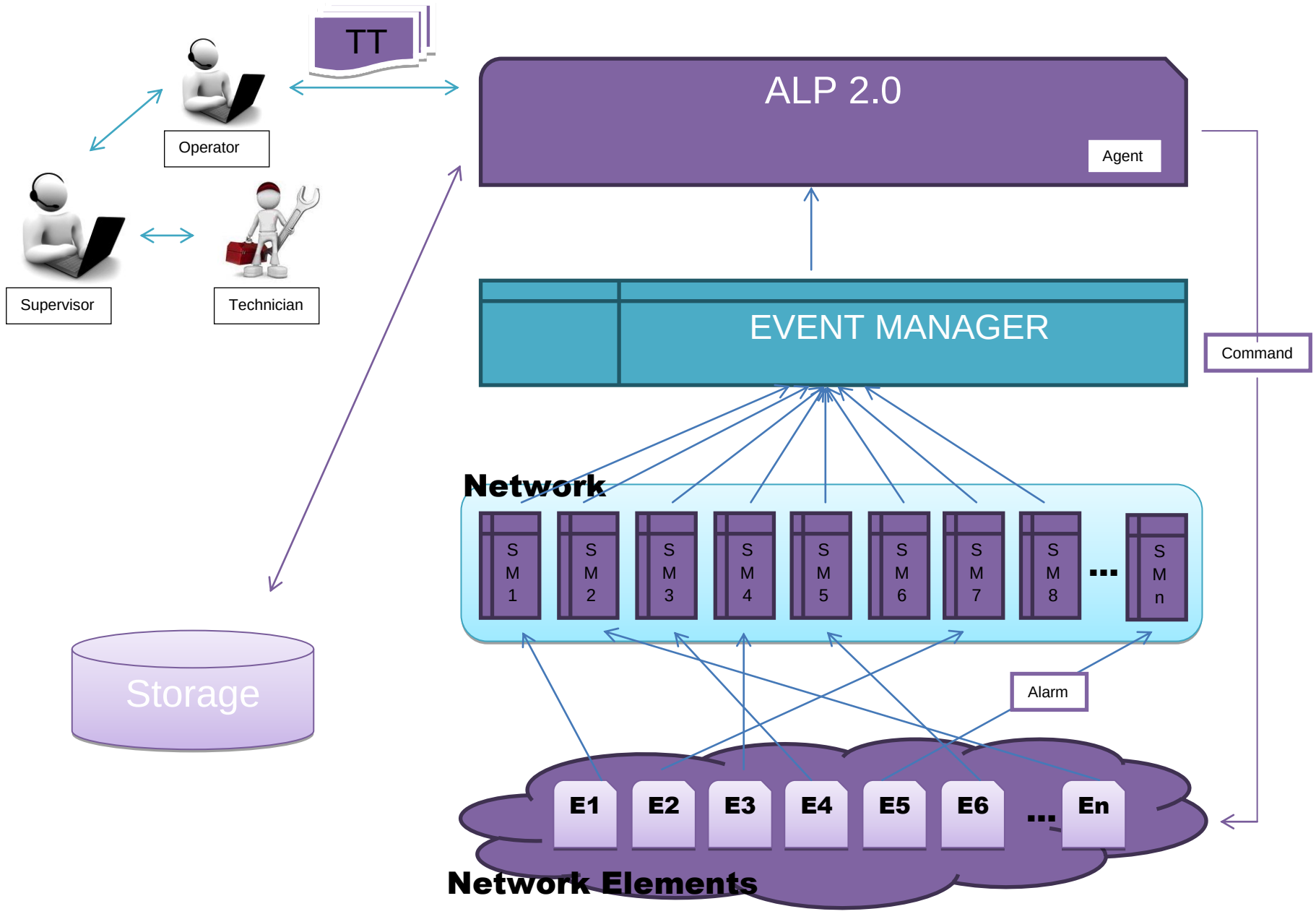

Figure 20 – ALP 2.0 Automation Process

6. Conclusions

In this chapter, I evaluate my work in Alcatel-Lucent and write the conclusions reached after this 6-month period. I will firstly go over the project conclusions, these will debate about if the job objectives were accomplished and how in what way they were satisfied. Afterwards I will expose my personal and professional conclusions which will talk about the personal experience I had in the company and will go over the professional achievements in terms of reached expectations.

6.1. Project Conclusions

At the beginning of the thesis I wrote a section talking about which were going to be my project objectives for this job I completed recently in Alcatel-Lucent. In life, and in my opinion more deeply in software, it is difficult to accomplish stated objectives in the expected time, as normally there are a series of facts or setbacks that make this labour extremely hard to achieve. I know this may sound ideal, but I am glad to say that all objectives set were attained in the expected period of time and not at all roughly, were covered with successful results.

To start with, we achieved the organisation development for all of the seven technologies, and I personally could culminate my job with the two technologies that I was assigned, Mobile Access and Switching Fixed Access. Here I can summarize very briefly the objectives that were achieved:

- **Main Objective 1**: A well-structured and what is more important, a realistic plan was outlined in an easily understanding format for arranging the organisation of Mobile Access and Switching Fixed Voice technologies. The plan had no cracks and no other interpretation far from the intended one. The time line was realistic but not relaxed at all, trying the hardest during my four hours of working on the project per day with the sole aim of not getting behind the timeline and at the same time performing a quality job. The plan was developed keeping in mind that the exact number of elements to extract, collect and document was not known with precision, and were just estimations that further on translated into days and hours. This initial ignorance or inaccuracy positioned obliged us to set up a wider time line. Finally, we successfully went through this process achieving a planning that fixed perfectly with the work I afterwards developed.

- **Main Objective 2**: A good agent organisation was finally completed. I ended up gathering all agents and producing an information file for all of them that collected all of the alarms that are treated by the agent, this together with other relevant fields and a complete description of the jobs it carries out inside ALP for Mobile Access and Switching Fixed Voice technologies.. The information file looks further than this and contains information about those commands that agents have predefined for executing in some previewed situations.

- **Main Objective 3**: Commands are already structured and organised in their corresponding technologies. They have a complete and helpful description attached as well as complete information about their attributes and the consequences of their execution in each situation. Summarizing, commands for Mobile Access and Switching Fixed Voice technologies are collected in the same format as other technologies and documented in such a way that any developer from another country may understand its functionality.

- **Main Objective 4**: This objective has also been covered, all the alarms are managed and documented. Now it is possible to open an alarm file and view all its information, every single field that could describe the alarm is already recorded as well as the facts that may shoot an alarm and those elements in charge of attending it later. Alarms' reports also contain data about the periodicity of those alarms that are proactive, even though this is an extra, but as I accomplished all of the main objectives I finally decided to realise this labour too.

- **Main Objective 5**: May seem one of the less important objectives to be accomplished, but even though trouble tickets are last step in the automation process chain, they are not least. The reason for saying this is that TT are the ones registered in the database in order to keep learning and enriching the system, as well they are the responsible for alarming operators in case a major error occurs. Well, all this has also been accomplished and TT are documented and provided of essential data to be able to inform about trouble situations with determinant information.

6.2. Personal & Professional Conclusions

Now it is time to evaluate the other conclusions, that may not be as useful for the project development as the ones just described, but that are really important to fulfill in the personal scope.

I stated once three main objectives to attain. The first aim was to be able to work and dynamically interact with international workers from the company inside the project. I can gladly confirm this has happen during my stay in Alcatel-Lucent, and it happened with successful results. At the beginning I was a little bit confused about how these foreigners working methodologies would be, finally I can say they are just like us, good workers from which I would highlight punctuality and respect. Also mention that in relation to the language everything went perfectly, we always understood each other without necessity of repeating our words.

Improving my Curriculum Vitae was something that mattered me before entering in ALU. I still give importance to this fact and obviously I achieved it, although I knew I was going to accomplish this objective when I was notified that they wanted me for the job. But it is not less true that with the pass of the days inside the company I started to give more weight to the last objective I mentioned in the introduction of this thesis, gaining experience and learning from it as much as I could. I sincerely believe that know I am a different person, someone more capacitated to solve complex situations and face with faith problems that in the past would of make me hesitate. This gained experience added to my skills improvement denote I grew quite a lot, becoming a mature and qualified person.

6.3. Following steps

What makes this paragraph be called “Following Steps” and not “Possible Improvements” is the fact that the project has not been concluded yet, and so nowadays we do not know which are the improvements that should be implemented for the following version of ALP.

The next step the team should take in the project is to develop PORALP system integration, manage ALP to run over PORALP platform correctly. The company has already started these processes, but still there is lot to do. This is something we can look at in section 3.2

Yes I can talk about my personal improvements for my next job, the way in which I can amend my performance. In my opinion this is something that one learns with the pass of years by accumulating experience, even though, I can think of something that might have been helpful or may be determinant to improve my performance at work. This fact I refer to, is to completely center my attention in the job I am carrying out in the company. This was not possible as at the same time I kept in mind that every afternoon I had to assist to university or attend to exams. From my point of view this was not an impediment when working at the company, but I was constantly under pressure or feeling overwhelmed.

Never mind, I hope to end up university in a couple of months and be able to pay whole attention to my professional career.

7. Abbreviations & Acronyms

Abbreviation	Full Term
ACL	Access Control List
AES	Advanced Encryption Standard
ALU	Alcatel-LUcent
ALP	Alcatel-Lucent Project
AM	Actuation Module
AMG	Actuation Module Group
API	Application Programming Interface
ARCH	Architecture
BSS	Business Support Systems
CLI	Command-Line Interface
CV	Curriculum Vitae
DB	Database
DES	Data Encryption Standard
DSA	Digital Signature Algorithm
EM	Event Manager
EMS	Event Management System
FTP	File Transfer Protocol
GUI	Graphical User Interface
HLD	High Level Design
IC	Indirect Costs
IDS	Intrusions Detection System
IP	Internet Protocol
IPR	Intellectual Property Rights
IPS	Intrusion Prevention System

IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISBAN	Banking Software Engineering
LLD	Low Level Design
L&F	Look and Feel
NDA	Non-Disclosure Agreement
NTP	Network Time Protocol
OB	Business Organization
OSS	Operations Support Systems
O&M	Operations and Maintenance
PORALP	Platform on which Runs Alcatel-Lucent Project
RDD	Requirements Definition Document
REQ(S)	Requirement(s)
RTM	Release to Manufacturing
SAD	Software Architecture Document
SEP	Systems Engineering Process
SDD	Solution Definition Document
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
SS	Social Security
SSH	Secure Shell
Telecli	Telecommunication Client
TLC	Telecli
TT	Trouble Ticket
VAT	Value Added Tax
XML	Extensive Markup Language

8. References

[1] - Alcatel-Lucent documentation - World Annual Expansion Review

[2] - http://www3.alcatel-lucent.com/wps/portal/AboutUs/factsheet

[3] - Alcatel-Lucent documentation – Project Expansion Plan

[4] - Alcatel-Lucent documentation - SDD

[5] - Alcatel-Lucent documentation - SAD

[6] - Alcatel-Lucent documentation - Executive-Review

[7] - Telecli documentation - SAD

[8] - Alcatel-Lucent documentation - RDD